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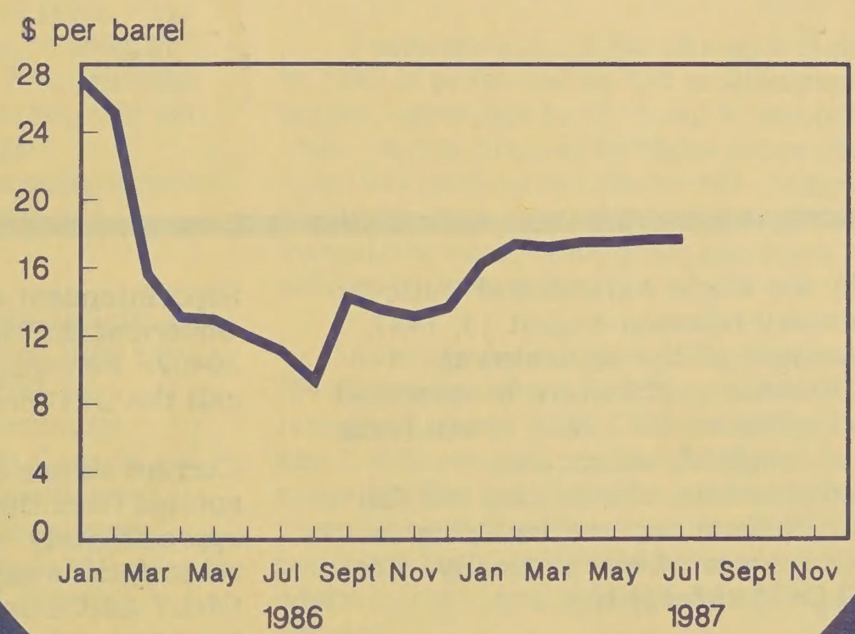

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SUMMARY

New and used farm machinery expenditures fell to $4.7 billion in 1986, 16 percent below 1985. Although farm net cash income continues to grow, expenditures are likely to remain weak this year, ranging from $4.1 to $4.7 billion. Reductions in planted acres, the reduced level of crop prices, high real interest rates, and an apparent propensity of farmers to reduce their debt burdens are contributing to the continued weakening in farm machinery demand.

At an expected 4,500 units, sales of new self-propelled combines will be 41 percent below last year. Unit sales of new over-99 horsepower (hp) two-wheel drive tractors are forecast to fall 35 percent to 9,200 units in 1987. Sales of 40-99 hp tractors may decline 9 percent to 28,000 units. On the positive side, forage harvestor sales are projected to rise 34 percent and sales of new balers and mower conditioners are expected to be stable. With sales of new tractors and combines slipping to pre-1970 lows, used machinery now provides an increasingly significant portion of total farm machinery expenditures.

As of April 1987, domestic manufacturers had reduced inventories of selected farm machinery from a year earlier. April inventories relative to sales ranged from 9 to 12 months for wheel tractors, 9 to 14 months for harvesting equipment, and 15 to 16 months for haying equipment. Because inventories are still above the 6- to 8-month target established by many machinery manufacturers, production facilities will be operating at minimal levels.

The U.S. farm machinery trade deficit grew 129 percent from first-quarter 1986 to first-quarter 1987. Export sales fell 15 percent, largely because of the continued shrinkage of traditional markets in Canada and Australia. At $450 million, farm machinery imports leveled off from the previous year, primarily because of reduced imports of under-40 and 40-99 hp two-wheel drive tractors.

Crude oil acquisition costs to U.S. refiners are likely to average $18 per barrel in 1987. Costs ranged from $15 to $18 per barrel during the first half of the year and are likely to be between $18 to $22 for the remainder if OPEC achieves its production goals.

Farmers can expect adequate supplies of diesel fuel, gasoline, and LP gas this year. Farm fuel prices have risen throughout 1987 and are expected to be slightly higher than year-earlier levels, but still much lower than in 1985. Farm energy expenditures are projected to decline more than 4 percent as an 8-percent reduction in planted acreage will more than offset price increases. Farm fuel use this year is projected to decline 9.5 percent.

Leaded gasoline is no longer being carried by some fuel suppliers and may not be readily available within 5 years. Although diesel engines provide the principal source of power for tillage, planting, and harvesting on farms, millions of gasoline tractor, combine, truck, and specialized equipment engines are still in use. Many of these engines risk excessive valve seat wear if fueled with unleaded gasoline. Farmers should continue to use leaded gasoline as long as it is available, install hard valve seats when engines are overhauled, and explore other options for reducing risks when using unleaded gasoline.

Pesticide use on the 10 major field crops in 1987 is projected at 430 million pounds, active ingredient (a.i.), down 9 percent from 1986. Acres planted to these crops declined from 267 million in 1986 to 246 million. Acres planted to corn, a major herbicide and insecticide user, were down the most--10.6 million (14 percent).

Average farm-level prices for herbicides ($4.05 per pound a.i.) and insecticides ($10.25) remained stable from 1986 to 1987. Atrazine and 2,4-D prices rose 3 and 8 percent, respectively, but the price of alachlor dropped 5 percent. Carbofuran and synthetic pyrethroid prices declined 7 and 5 percent, while methyl parathion prices advanced 3 percent.

On July 15, the Environmental Protection Agency (EPA) initiated a Special Review of the ethylene bisdithiocarbamate (EBDC)

fungicides, which are broad-spectrum fungicides important in the production of apples, potatoes, tomatoes, and several other vegetable, fruit, and speciality crops. EPA cited the potential risk of cancer to consumers of the treated products and of adverse thyroid effects and birth defects to workers who mix, load, and apply EBDC fungicides.

The U.S. trade balance in pesticides was $1 billion in 1986, down from the peak of $1.1 billion in 1984, but higher than 1985's $900 million. Pesticide exports in 1986 were valued at $1.4 billion, with herbicides accounting for 44 percent of the total value, followed by insecticides with 36 percent and fungicides with 16 percent.

Plant nutrient use in 1986/87 is projected at 18.5 million tons, down about 6 percent from a year earlier. Although supplies were smaller than a year ago, prices in April were down more than 6 percent because of decreased domestic demand. Increased world fertilizer demand and stable or declining prices spurred U.S. fertilizer exports, while projections of lower domestic use discouraged U.S. imports of nitrogen and potash.

FARM MACHINERY

Demand

Last year, expenditures for new and used farm machinery were $4.7 billion, a 14-year low and a 16-percent drop since 1985. Outlays could be lower in 1987 as expenditures are forecast to be from $4.1 to $4.7 billion (table 1). While the financial position of farmers has begun to strengthen, demand for farm machinery will be cooled by reductions in crop acreage. An estimated 23 percent of total U.S. cropland acreage will be idle in 1987, well above the 15 percent idled in 1986.

Real interest rates faced by farmers are still high by historical standards and may increase slightly to 8.9-9.3 percent this year. Farmers' net cash income is expected to range between $52 and $56 billion in 1987, possibly surpassing the record of $53 billion set in 1986. Farmers' equity position, as measured by the debt-to-asset ratio, improved marginally, moving from 23.7 percent in 1985 to 23.3 percent in 1986 and is forecast to fall to between 20 and 22 percent this year. The decline in the debt asset ratio is based on a forecast for stabilization of farm asset values and for continued farm debt retirement in 1987.

Domestic unit sales of new farm machinery are forecast to fall in 1987 with the exception of forage harvesters and mower conditioners (table 2). Unit sales of over-99 horsepower (hp) two-wheel drive tractors are forecast to fall 35 percent, more than any other tractor class. The expected rise in forage harvester and mower conditioner sales and near-stable sales in balers reflect the recent increase in the profitability of beef production. The continued falloff in sales of new farm machinery indicates farmers' willingness to maintain their own machines or to purchase used machinery. The past responses to dealer incentive programs indicate that the level of unit sales in 1987 will continue to depend on these programs.

Determinants of Machinery Investment

In the first half of the 1980's, falling farm commodity prices lowered investment returns and high real interest rates increased investment costs of farm machinery. The fall in farm asset values in the 1980's eroded farmers' equity position and limited their ability to obtain financing. While interest rates, equity, and net cash income remain important, the Food Security Act of 1985, with its goal of reducing Government's role in agriculture, will affect farm machinery purchases throughout the decade if support prices are lowered and cropland continues to be idled. Farm machinery purchases should pick up once surplus stocks are worked down, market prices begin to rise, and cropland is brought back into production.

Any decrease in nominal interest rates in 1987 will help improve the farm sector's cash flow by lowering interest expenditures. However, real interest rates remain high and thus will continue to exert downward pressure on farm machinery sales.

Demand for farm machinery is directly influenced by the rate of return that

Table 1--Trends in U.S. farm machinery capital expenditures and financial factors affecting demand for farm machinery

Item	1982	1983	1984	1985	1986	Forecast 1987
				Billion dollars		
Capital expenditures:						
Tractors 1/	2.60	2.61	2.54	1.94	1.51	1.1-1.4
Farm machinery 1/	5.07	4.74	4.68	3.66	3.19	3.0-3.3
Total 1/	7.67	7.35	7.22	5.60	4.70	4.1-4.7
Tractor and machinery repairs	3.6	3.7	3.8	3.7	3.7	3.5-4.0
Factors affecting demand:						
Interest expenses	21.8	21.4	21.1	18.7	16.9	15-16
Total production expenses	141	140	143	134	122	110-120
Outstanding farm debt 2/	217	216	212	205	187	165-175
Farm real estate assets 2/	809	798	694	607	559	550-570
Farm nonreal estate assets 2/	273	264	262	259	245	240-250
Agricultural exports 3/	39.1	34.8	38.0	31.2	26.3	25-27
Net farm income	23.4	12.7	32.2	32.1	38.2	40-44
Net cash income	38.0	37.1	38.9	47.0	52.7	52-56
				Percent		
Real prime rate 4/	8.4	7.0	8.1	6.6	4.7	5.5-6.0
Nominal farm machinery and equipment loan rate 5/	17.1	14.3	14.6	13.7	12.2	7/ 11.2
Real farm machinery and equipment loan rate 4/	10.6	10.5	10.3	10.4	8.6	8.9-9.3
Debt-asset ratio 6/	20.0	20.3	22.2	23.7	23.3	20-22

1/ Expenditure estimates vary from previsouly reported estimates due to improvements in the estimation method. 2/ Calculated using nominal dollar balance sheet data, including farm households for December 31 of each year. 3/ Fiscal year. 4/ Deflated using 1982 GNP Deflator. 5/ Average annual interest rate. From the quarterly sample survey of commercial banks: Agricultural Financial Databook, Board of Governors of the Federal Reserve System. 6/ Outstanding farm debt (including households) divided by the sum of farm (including households) real and nonreal estate asset values. 7/ Average of the first and second quarters of 1987.

Table 2--Domestic farm machinery unit purchases

Machinery category	Annual average 1978-80	Annual average 1981-84	1985	1986	Forecast 1987	Change 1986-87
			Units			Percent
Tractors:						
Two-wheel drive						
40-99 hp	62,818	42,131	37,847	30,848	28,000	-9
Over-99 hp	59,543	31,272	17,700	14,262	9,200	-35
Four-wheel drive	10,276	6,385	2,912	2,037	1,500	-26
Grain and forage harvesting equipment:						
Self-propelled combines	29,834	16,805	8,411	7,660	4,500	-41
Corn heads	20,338	9,560	5,016	4,716	2,500	-47
Forage harvesters 1/	11,145	5,093	2,460	2,164	2,900	34
Haying equipment:						
Balers 2/	17,501	9,975	7,038	5,734	5,600	-2
Mower conditioners	23,392	14,954	11,243	10,898	11,100	2

1/ Shear bar type. 2/ Producing bales up to 200 pounds.

Source: Historical data are from the Farm and Industrial Equipment Institute (FIEI). Unit sales for 1987 are ERS forecasts.

machinery is expected to generate. The rate of return to farm equipment is directly related to crop prices. Thus, farm machinery sales are adversely affected by falling crop prices.

Farm net cash income in 1987 is expected to exceed the $53-billion mark reached in 1986 because of expected lower production expenses, stronger meat animal prices, and record-large direct Government payments. Cash receipts are forecast to fall 5 to 7 percent as rising cattle and hog earnings are not likely to compensate for lost revenue from both falling crop prices and reduced crop production. However, direct Government payments are expected to increase roughly 25 percent to $14-$16 billion. Production expenses in 1987 are expected to fall 4 to 6 percent as the number of acres planted continues to decline and input application rates fall.

Recent gains in farm net cash income have been largely used to retire debt. Farmers are expected to continue using additional income to retire debt in 1987. Approximately $18 billion in farm debt was retired or written off by lenders in 1986 and the same is expected in 1987. No gain in equity was made in 1986, despite the debt retirement, due to a $62-billion fall in asset values. Because asset values are expected to hold steady in 1987, farm equity is expected to improve. The debt-to-asset ratio is expected to fall to between 20 and 22 percent.

The Food Security Act of 1985

The 1985 farm bill continued USDA's authority to implement acreage reduction programs through 1990, authorized voluntary paid land diversion for feed grains, and established the Conservation Reserve Program (CRP) to idle highly erodible cropland for 10 years. Commodity price supports are to be lowered in an attempt to make U.S. agricultural commodities more competitive in world markets. However, farm income will continue to be supported through marketing loans, deficiency payments, paid land diversions, and the CRP.

Government programs have always been an important determinant of farm real and nonreal estate investment demand. Commodity price supports guarantee program participants a floor price and thus ensure some return on land and farm machinery investments. However, the adjustment by farmers to lower commodity support prices authorized by the 1985 farm bill will likely curb farm machinery demand during the next 2 to 3 years.

Acreage Reductions

Idled acres in 1987 are expected to increase 56 percent over 1986. As many as 71.4 million acres, including 17 million in the CRP, may be idled. This would constitute 23 percent of the total U.S. cropland planted to 15 major field crops.

Expenditures on farm machinery will be adversely affected by the rise in idled acres. Reductions in acres planted and harvested imply less farm machinery use. Consequently, the net rate of return on farm machinery investments will be lower (e.g. fixed costs are spread across fewer acres) even though some tillage may be performed on idled acres. Working machines fewer hours decreases wear and need for replacement. Also, farmers with fewer acres in production may sell some machinery and thus provide the farm sector with an inexpensive alternative to new equipment.

On the other hand, acreage reductions will have some positive effects on farm machinery demand: Program payments stand to improve the financial condition of participating farmers and, by lowering the supply of program crops, acreage reductions may keep crop prices higher than they would have been without a program.

Financial Conditions

While financial stress has been a factor in depressing farm machinery sales, the majority of commercial farmers limited their 1986 machinery purchases for reasons other than the lack of credit. For example, over 44 percent of all commercial farms (annual sales above $40,000) in the United States had net cash flows that exceeded capital replacement and principal requirements and an equity base that would permit expansion. However, there are those farmers who have debt problems and those who can not afford more debt. Fourteen percent of all farms had a serious debt problem with a net cash flow-to-equity ratio less than negative 5 percent and a

debt-to-asset ratio greater than 70 percent. Twenty-one percent had adequate equity to refinance their debt to an operational level. The remaining 21 percent are considered stable with adequate cash flow or equity to continue operating.

Capital Replacement

Two important influences on farm machinery purchases are the amount of wear the machine has received and the efficiency gains that new machinery offer. Since the early 1960's, the efficiency gains available from use of larger tractors have led to increased use of over-99 hp tractors. The adoption of larger tractors and larger implements has helped lower per unit commodity production costs.

An examination of the tractor sizes used in agriculture provides an indication of the adoption of larger implements. Most acres in wheat, corn, soybean, and cotton production in 1986 were tilled by tractors in excess of 99 hp (table 3). Tractors of 120-139 hp are the most popular for tilling these crop acres. Though the 120-139 hp tractor is a popular size for planting purposes, smaller tractors play a significant role because soil compaction is reduced and power requirements for planting are typically lower than for tillage operations.

The continuation of a shift by farmers to the larger equipment (associated with the over-99 hp tractors) does not offer much market potential for the larger equipment. In 1986, only 12, 17, 13, and 5 percent of the wheat, corn, soybean, and cotton acres, respectively, were tilled using under 100 hp tractors. However, improved tractor design and the associated efficiency gain are not measured by horsepower alone. For example, lesser powered four-wheel drive and front-wheel assist tractors can pull loads as heavy as those pulled by more powerful

Table 3--Tractor use and average age by horsepower class in tillage and planting for 1986 1/

Horsepower	Wheat		Corn		Soybeans		Cotton	
	Percent of acres	Mean age 2/	Percent of acres	Mean age	Percent of acres	Mean age	Percent of acres	Mean age
				Primary tillage 4/				
40-99	12	16	17	17	13	16	5	17
100-119	7	12	10	12	8	11	8	10
120-139	17	11	26	10	24	10	29	8
140-159	16	9	17	9	20	9	23	8
160-179	9	8	10	8	10	8	8	6
180-199	11	7	6	7	13	7	17	5
200-249	17	7	8	8	6	8	5	7
250-299	5	7	5	7	5	7	4	5
300 and over	5	5	*	*	*	*	*	*
Total 3/	5/ 100	10	100	11	99	10	99	8
				Planting				
40-99	22	18	45	18	34	17	17	17
100-119	7	11	13	12	14	11	11	10
120-139	24	10	25	9	25	10	36	8
140-159	15	8	10	9	14	9	21	7
160-179	8	8	3	8	5	7	7	5
180-199	7	7	3	6	7	6	7	5
200-249	9	7	**	**	1	8	**	**
250-299	4	7	**	**	**	**	**	**
300 and over	4	5	*	*	*	*	*	*
Total	99	11	98	13	99	12	99	9

* = Value included in previous horsepower range.
** = Statistically insignificant.

1/ Surveyed States for each crop are listed in Tables 4, 5, 6, and 7. 2/ Mean age weighted by acres worked. 3/ Represents all tractors in the above horsepower classes. A 100 percent total of acres worked indicates that tillage by under 40 horsepower tractors was insignificant. 4/ Primary tillage equipment (e.g., mold-board plow, heavy tandem disk, etc.) act to displace and shatter soil burying or mixing plant materials in the tilled layer. 5/ The above may not add due to rounding.

two-wheel drive units. Also, the installation of minicomputers and sensors which provide an accurate measure of ground speed allow planting and tillage operations to be performed at the desired speed with greater fuel efficiency. The efficiency gains from advances in tractor technology will help determine future tractor sales.

The age of tractors indicates two important factors. First, with the average age of tractors under 100 hp exceeding 16 years, there are a number of tractors in this horsepower range for which it soon may be cost effective to replace. Second, the high average age of tractors indicates that they are used beyond their life established for tax purposes.

Approximately half of all acres are tilled by the over-140 hp tractors. These higher horsepower tractors tend to be newer than the smaller tractors, indicating less need for tractor replacement to continue working these acres (assuming tractors have maintained their durability).

Tillage Practices

The moldboard plow is not a major tillage implement within the United States for wheat, corn, soybeans, or cotton (tables 4, 5, 6, and 7). Over the last few years, high energy costs, concern for soil conservation, and the desire to conserve soil moisture have led to a movement away from conventional tillage and have helped create a demand for reduced tillage equipment. Across the United States, more acres are worked with a heavy tandem disk than the moldboard plow.

Tillage practices reflect an area's soil type, rainfall, and cropping patterns. In States with abundant rainfall, a deep tilling chisel plow is often used to break up the subsoil to improve drainage. In drier areas, a lighter chisel plow is drawn through the topsoil to loosen the root zone without burying all crop residue. For example, the most commonly used tillage implement in Montana wheat production is the chisel plow. Last year, the chisel plow was used on a greater share of wheat acres in Montana (76 percent) than any

Table 4—Total implement use and implement use combinations in wheat production, 1986

Category/combination	AR	CA	CO	ID	IL	IN	KS	MN	MO	MT	NE	ND	OH	OK	OR	SD	TX	WA	Total
									Percent of planted acres										
Moldboard plow total: 1/	–	13	–	29	5	5	26	28	7	–	17	10	10	27	41	8	–	7	13
Plow + harrow + fld cult 2/	–	–	–	6	–	–	–	7	–	–	3	–	–	–	8	–	–	–	–
Heavy tandem total:	85	12	25	32	75	84	31	16	64	5	55	8	48	22	17	46	40	27	28
Hvy tandem only	45	–	2	4	51	65	3	–	50	–	–	–	36	–	–	7	11	5	7
Hvy tandem + chsl plow	–	3	–	–	–	–	–	–	5	–	–	–	–	2	–	13	7	–	2
Hvy tandem + harrow	15	–	2	7	9	3	–	–	–	–	11	–	–	–	5	2	–	6	–
Hvy tandem + fld cult	19	–	–	–	3	–	5	6	5	–	–	3	–	–	–	13	3	–	3
Chisel plow total:	–	9	28	19	5	3	19	46	15	76	32	59	3	47	36	46	42	40	35
Chsl plow only	–	–	–	–	3	–	–	3	–	64	–	7	–	3	–	9	3	–	7
Chsl plow + harrow	–	–	–	4	–	–	–	–	–	11	–	–	–	4	16	4	–	5	2
Chsl plow + harrow + fld cult	–	–	–	2	–	–	–	7	–	–	2	7	–	–	4	–	–	15	–
Chsl plow + fld cult	–	–	–	–	–	–	–	22	–	–	–	30	–	–	–	11	–	–	4
Wide-sweep plow total:	–	–	55	3	–	–	42	–	–	10	17	5	–	28	–	4	38	7	21
Wide-sweep plow only	–	–	22	–	–	–	9	–	–	6	–	2	–	–	–	–	14	–	5
Disk total:	7	88	28	30	10	11	40	3	22	2	18	5	39	51	23	14	30	24	25
Disk only	5	16	–	–	8	3	–	–	6	–	2	–	29	3	–	–	7	–	3
Harrow total	17	15	38	35	9	7	38	35	4	15	67	14	4	36	72	8	4	79	26
Field cultivator total:	19	5	5	23	8	3	27	79	13	4	25	72	3	19	19	36	15	45	24
Fld cult only	–	–	–	–	4	–	–	12	5	–	–	9	–	–	–	2	–	–	–
No-till	6	–	3	10	6	2	–	–	13	9	3	3	7	4	2	10	–	2	5
										Number									
Times over the field	3	4	4	3	2	2	5	4	2	3	5	4	2	4	4	3	3	4	3

– = Less than 2 percent reported.

1/ The implement total indicates the portion of total acres the implement was used on. 2/ Only the most significant implement combinations are listed. Specific implement combinations are shown under only one category. For example: the plow + harrow + field cultivator combination is not listed under the harrow or field cultivator categories. However, acres worked with the plow + harrow + field cultivator combination are included in the harrow and field cultivator totals.

Table 5--Total implement use and implement use combinations in corn production, 1986

Category/combination	IL	IN	IA	MI	MN	MO	NE	OH	SD	WI	Total
	Percent of planted acres										
Moldboard plow total: 1/	13	27	13	39	31	14	6	39	26	55	22
Mldbrd plow + heavy tandem 2/	–	4	2	7	4	5	2	–	5	5	3
Mldbrd plow + disk	–	6	2	12	6	–	–	17	3	12	5
Mldbrd plow + fld cult	4	5	3	8	12	–	–	14	6	3	5
Heavy tandem total:	33	21	46	21	15	45	66	8	49	35	35
Heavy tandem only	9	3	14	4	4	8	30	2	17	6	11
Hvy tandem + fld cult	7	4	15	–	–	13	25	–	13	–	9
Chisel plow total:	31	40	14	35	31	33	12	23	27	26	25
Chsl plow + disk	6	13	3	8	3	2	5	7	3	5	5
Chsl plow + fld cult	6	9	5	12	17	11	–	10	10	3	8
Disk total	31	36	23	34	21	19	14	39	20	42	27
Harrow total	9	8	11	8	14	9	4	10	17	29	11
Field cultivator total:	52	39	58	38	59	52	32	36	41	14	45
Field cultivator only	14	5	18	5	19	12	4	6	5	–	11
No-till	6	13	5	7	4	5	13	20	3	5	15
	Number										
Times over the field	2	2	2	2	3	2	2	2	3	3	2

– = Less than 2 percent reported.

1/ The implement total indicates the portion of total acres the implement was used on. 2/ Only the most significant implement combinations are listed. Specific implement combinations are shown under only one category. For example: The plow + heavy tandem combination is not listed under the heavy tandem category. However, acres worked with the plow + heavy tandem combination are included in the heavy tandem total.

Table 6--Total implement use and implement use combinations in soybean production, 1986

Category/combination	AL	AR	GA	IL	IN	IA	KY	LA	MN	MS	MO	NE	NC	OH	TN	Total
	Percent of planted acres															
Moldboard plow total: 1/	19	4	11	21	43	22	7	2	39	–	7	5	21	49	9	21
Mldbrd plow + disk 2/	5	–	11	4	10	3	3	2	3	–	–	–	12	13	4	6
Mldbrd plow + fld cult	–	2	–	5	17	3	–	–	19	–	–	–	–	18	–	6
Heavy tandem total:	46	68	56	40	19	56	42	75	17	66	64	86	54	13	53	47
Heavy tandem only	5	4	27	7	7	8	9	12	9	6	12	23	17	2	–	9
Hvy tandem + chsl plow	11	–	8	6	2	–	4	–	–	–	2	2	3	–	–	2
Hvy tandem + chsl plow + fld cult	4	6	–	3	–	3	5	8	–	16	–	2	–	–	3	3
Hvy tandem + harrow	–	9	–	–	–	4	7	9	–	–	–	4	3	–	7	3
Hvy tandem + fld cult	15	13	5	7	2	22	–	31	6	10	30	53	–	6	3	15
Chisel plow total:	51	31	22	39	30	18	36	19	24	42	19	7	12	20	41	26
Chsl plow + disk	24	6	8	8	9	–	17	2	2	3	3	–	7	6	16	5
Chsl plow + fld cult	–	3	–	8	7	4	3	–	12	3	4	–	–	8	–	5
Disk total:	56	29	36	37	35	35	41	25	28	25	23	6	50	38	30	32
Disk + fld cult	–	4	–	3	2	7	–	5	7	5	6	–	–	–	–	4
Harrow total	6	15	–	5	8	12	12	16	17	16	4	5	6	11	12	10
Field cultivator total	52	48	6	50	40	65	14	53	60	60	60	63	–	54	20	50
No-till	5	–	2	4	–	–	17	4	3	5	–	6	18	10	10	5
	Number															
Times over the field	3	4	3	3	3	3	3	4	3	4	3	3	3	3	4	3

– = Less than 2 percent reported.

1/ The implement total indicates the portion of total acres the implement was used on. 2/ Only the most significant implement combinations are listed. Specific implement combinations are shown under only one category. For example: the plow + disk combination is not listed under the disk category. However, acres worked with the plow + disk combination are included in the disk total.

other State (table 4). On 64 percent of the acres in Montana, the chisel plow alone adequately prepared the soil for planting. An additional 11 percent of the State's wheat acres were prepared by a combination of the chisel plow and a harrow. In States with greater rainfall, use of the chisel plow alone or in combination with a harrow is uncommon.

Wheat production shows a significant variation in the average number of field passes performed by farmers across the different States. Nebraska and Kansas farmers averaged five passes over each field to control weed growth during the fallow period from the 1984 harvest to planting of winter wheat in 1985. On the other hand, Corn Belt States had the fewest number of field passes, probably due to planting winter wheat immediately after harvesting soybeans.

The field cultivator is a versatile secondary tillage implement used on a quarter of the acres in wheat and cotton production and nearly half the acres in corn and soybeans. Though usually used in conjunction with other tillage implements, it also is used alone as a reduced tillage method of soil preparation for wheat and corn.

Planting without any tillage operation can save time and energy. However, greater use of herbicides and insecticides may be required. Currently, no-till is most common and significant in Ohio corn, North Carolina soybean, and Montana wheat production. The low adoption of no-till practices may indicate that farmers have not found this tillage practice to be cost effective. However, the farmer does not necessarily receive all of the benefits from no-till agriculture. States such as Ohio have recognized the reduction in soil erosion and the potential improvement in water quality that no-till crop production provides, and thus have encouraged farmers to adopt such practices.

Unit Sales vs. Expenditures

Unit sales of new tractors and combines are expected to continue to fall in 1987 due, in part, to the reduction in planted acres (table 2). The profitability of the livestock industry

Table 7--Total implement use and implement use combinations in cotton production, 1986

Category/combination	AL	AZ	AR	CA	GA	LA	MS	MO	NM	OK	SC	TN	TX	Total
	Percent of planted acres													
Moldboard plow total: 1/	53	76	-	9	21	7	9	-	86	26	7	20	23	20
Mldbrd plow + disk 2/	5	11	-	-	-	-	-	-	11	4	-	-	-	-
Heavy tandem total:	31	13	50	10	63	59	47	68	45	20	53	69	31	35
Hvy tndm + chsl plow + hipping ridger + do-all	-	-	-	-	-	-	7	7	-	-	-	10	-	-
Hvy tandem + disk	8	-	-	-	4	2	-	-	-	2	8	-	-	-
Hvy tandem + hipping ridger + do-all	-	-	11	-	-	2	-	5	-	-	6	6	-	-
Chisel plow total:	36	13	29	44	11	41	37	39	19	70	25	57	53	45
Chsl plow + disk	3	2	-	13	-	3	-	-	-	-	10	-	2	3
Chsl plow + disk + do-all	11	-	-	-	-	-	-	-	-	-	2	11	-	-
Chsl plow + harrow	-	-	-	-	-	-	-	-	-	23	-	-	6	4
Disk total:	53	79	36	92	56	39	45	23	37	37	62	22	20	38
Disk + subsoiler	-	-	-	11	10	-	-	-	-	-	-	-	-	-
Hipping ridger total	5	10	67	-	48	66	57	73	9	-	13	30	13	24
Subsoiler total	7	12	43	23	23	51	42	13	8	10	45	6	3	17
Harrow total	4	9	10	9	-	21	9	4	14	45	4	9	29	20
Field cultivator total	32	10	41	19	11	41	45	7	5	10	7	4	27	27
Do-all total	66	10	70	3	19	54	85	57	-	-	32	95	5	26
No-till	3	-	-	5	-	-	3	-	3	2	6	-	-	3
	Number													
Times over the field	4	5	5	4	5	5	5	4	4	5	4	5	4	4

- = Less than 2 percent reported.

1/ The implement total indicates the portion of total acres the implement was used on. 2/ Only the most significant implement combinations are listed. Specific implement combinaions are shown under only one category. For example: the plow + disk combination is not listed under the disk category. However, acres worked with the plow + disk combination are included in the disk total.

is likely to help increase 1987 unit sales of new forage harvesters and mower conditioners and stabilize the sales of new balers.

The decline in tractor and combine unit sales represents a continuation of the trend begun in 1980. Last year, unit sales of the big ticket items–– over–99 hp two–wheel drive tractors, four–wheel drive tractors, and self–propelled combines––were 23, 18, and 24 percent, respectively, of their 1979 peak.

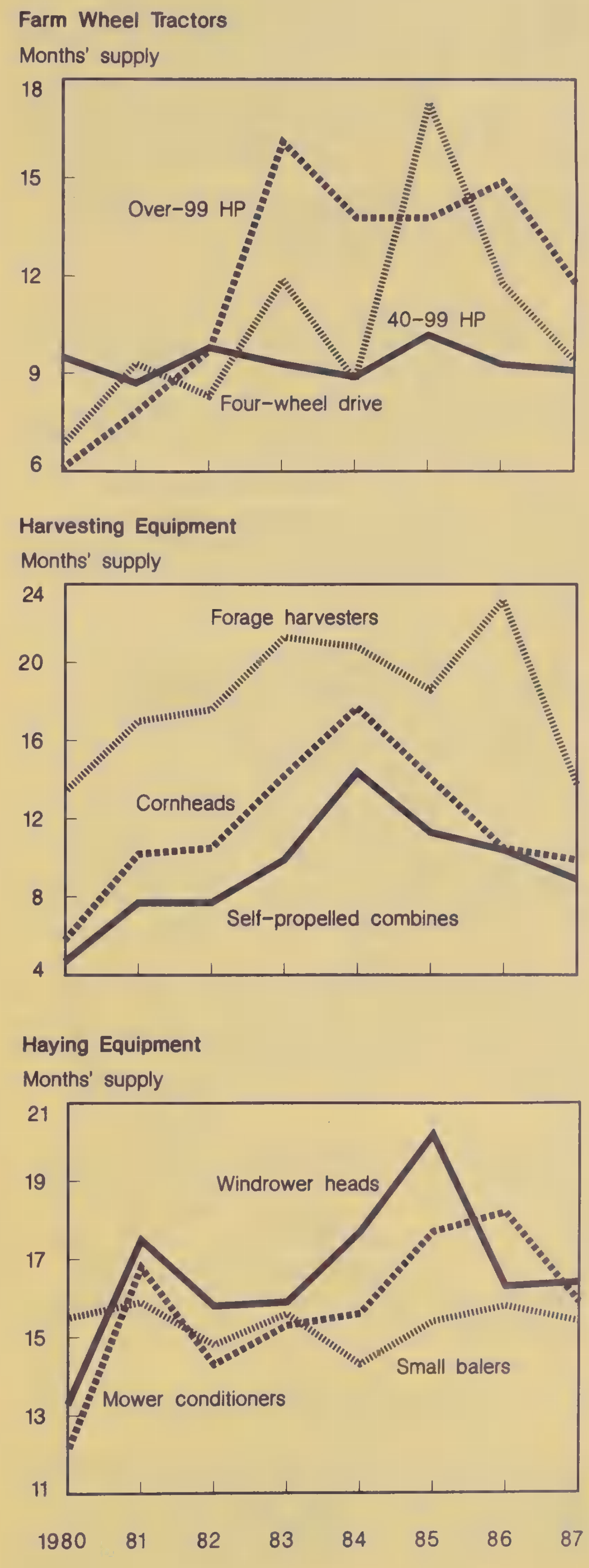
Since 1979, expenditures for new machinery have declined more than expenditures for used machinery. Annual real net expenditures (deflated by the GNP price deflator) for new and used tractors represent 17 and 39 percent, respectively, of their 1979 level. Expenditures for new tractors represented 59 percent of total tractor expenditures in 1979 and 38 percent in 1986. Thus, a one–percent decrease in new tractor expenditures in 1987 would have two–thirds the impact on total tractor expenditures as a one–percent decrease in tractor expenditures had in 1980.

With sales of new farm machinery at such low levels, a small change in new machinery sales (relative to 1979 sales) can represent a significant change relative to current annual sales. The low level of sales also indicates substantial room for sales to rebound. Thus, should farmers see higher prices for agricultural commodities or substantially lower real interest rates than those currently expected, new unit sales may exceed the forecasts presented here.

Supplies

As of April 1987, domestic farm machinery manufacturers were successful in their efforts to bring the absolute level of selected farm machinery inventories, more in line with demand. As a result, inventories relative to sales of wheel tractors (40–99 and over–99 hp two–wheel drive, and all four–wheel drive units) and selected harvesting and haying equipment are down from the previous year. However, farm machinery inventories are still above the 6– to 8–month target set by many manufacturers, and plants continue to operate at minimal rates. For an historical perspective on farm machinery inventories see Appendix A.

April Farm Machinery Inventories



As of April 1987, there was a 9-month supply of 40-99 hp two-wheel drive tractors and four-wheel drive tractors and nearly a 12-month supply of over-99 hp two-wheel drive tractors. Domestic manufacturers have had greater success in reducing April inventories of four-wheel drive tractors from their peak in 1985, than they have in reducing April inventories of other wheel tractors from their respective highs. All four-wheel drive tractor inventories relative to current demand have fallen 46 percent since 1985.

One reason manufacturers were able to reduce four-wheel drive tractor inventories is that the market is considerably smaller than either of the two-wheel drive markets; consequently, manufacturers have been better able to align production cutbacks with the decline in unit sales. Also, the financial troubles of several four-wheel drive tractor manufacturers have resulted in the prolonged suspension of production during the past few years.

In the harvesting equipment category, supplies of self-propelled combines (8.8 months), corn heads, (9.9 months), and forage harvesters (13.8 months) have been cut considerably. Self-propelled combine inventories relative to current demand are close to the goal set by the industry, while forage harvester inventories, although well above target, declined appreciably from April 1986 when they stood at 23 months.

By far, the haying equipment category (windrower heads, mower conditioners, and small balers) appears the most difficult for manufacturers to align production with the inventory-to-sales goal. As of April 1987, there was close to a 16-month supply of haying equipment. While haying equipment inventories are relatively high compared with those of wheel tractors and harvesting machinery, the lower value attached to these units possibly affords manufacturers more flexibility in terms of the need to pare down inventories.

Farm Machinery Trade

For the first quarter of 1987, the value of U.S. farm machinery exports declined 15 percent from a year earlier to $344 million while import value held constant at roughly $450 million. As a result, the U.S. farm machinery trade deficit grew 129 percent from a year earlier to $105 million (table 8). By comparison, the total 1986 U.S. farm machinery trade deficit was roughly $160 million.

Table 8--Farm machinery trade situation 1/

Trade/area	January-March 1985	1986	1987	Change 1986-87
	Million dollars			Percent
Exports to:				
Africa	18.5	18.0	15.2	-16
Australia	34.9	13.7	8.6	-37
Canada	181.2	192.5	161.4	-16
Central America 2/	7.7	10.8	9.6	-11
Eastern Europe	8.0	3.3	5.2	58
Far East	12.0	10.7	11.5	[illegible]
Mexico	49.1	26.3	14.3	-46
Middle East	5.0	3.7	3.6	-3
Near East	3.8	2.4	2.9	21
Oceania	0.7	0.8	0.7	-13
Saudi Arabia	23.1	11.4	16.7	47
South America	18.5	25.1	35.7	42
Western Europe	60.1	86.0	58.3	-32
Total	422.6	404.7	343.7	-15
Imports from:				
Africa	0.3	0.2	0.6	200
Canada	108.6	76.1	109.2	44
Central America 2/	0.4	1.5	2.2	47
Eastern Europe	5.5	7.9	4.5	-43
Far East 3/	3.5	3.4	5.0	47
Italy	32.1	30.5	29.3	-4
Japan	95.7	131.6	132.5	1
Middle East	2.4	2.9	2.6	-10
Near East	0.1	0.3	0.1	-67
Oceania	4.7	3.1	4.4	42
South America	4.7	3.5	3.7	[illegible]
United Kingdom	63.3	61.9	53.6	-13
West Germany	57.4	78.5	54.3	-31
Western Europe 4/	41.1	49.2	46.7	-5
Total	419.8	450.6	448.7	0
Trade balance 5/	2.8	-45.9	-105.0	129

1/ Includes finished machinery items, nonassembled machinery, and parts. 2/ Includes Caribbean countries. 3/ Excluding Japan. 4/ Excluding Italy, the United Kingdom, and West Germany. 5/ Trade balance is slightly overstated due to rounding of country export and import totals.

Source: U.S. Department of Commerce. Trade Development, Office of Special Industrial Machinery.

Structural adjustments in the domestic industry such as the transfer of the domestic under-40 and 40-99 hp tractor production capacity abroad and a deterioration in traditional U.S. export markets (Canada and Australia) are two of the major factors influencing the present trade situation. It appears that the United States could remain a net importer of farm machinery for an indeterminate length of time.

First-quarter gains in the value of U.S. machinery exports were most significant in South America (42 percent), Saudi Arabia (47 percent), Eastern Europe (58 percent), and the Near East (21 percent). However, these trade

partners account for only 18 percent of the total U.S. farm machinery export base. In many instances, exports to these markets are a short-term phenomenon motivated by agricultural projects that require specialized equipment such as irrigation systems. Because the United States primarily specializes in the production of large capacity, high-valued equipment such as over-99 horsepower (hp) wheel tractors and self-propelled combines, international markets are limited. Only Canada and Australia have the type of capital intensive production practices suited for these types of machinery.

Canada accounts for 48 percent of the total value of U.S. farm machinery exports. First-quarter exports to Canada were down 16 percent to $161 million from $193 million in 1986. Historically, Australia has been the second most important trade partner, but its demand has stagnated. The value of farm machinery exports to Australia declined 37 percent in the first quarter.

Currently, Western Europe is the second most important market, but under the current domestic industry restructuring, exports to Western Europe are linked to U.S. foreign subsidiaries and the demand for 40-99 hp (mid-size) two-wheel drive tractors. Although a greater percentage of all mid-size tractor production activity is accomplished overseas, a common practice for domestic companies is to ship component parts or partially assembled machines to Western European subsidiaries. Subsequently, many of the completed machines are reshipped to the United States duty-free. However, as the domestic market for 40-99 hp (mid-size) two-wheel drive tractors contracts, exports to Western Europe and likewise imports from Western Europe will decline.

For example, first-quarter farm machinery exports to Western Europe were $58 million, down 32 percent from a year earlier. This decline can be largely attributed to the depressed domestic market for mid-sized tractors. An examination of the import flows from the primary Western European suppliers of mid-sized tractors bares this out.

While the value of farm machinery imports from all other Western European countries is down 5 percent, the value of imports from Italy, the United Kingdom, and West Germany are down a respective 4, 13, and 31 percent from the first quarter of 1986. The general downtrend in the value of exports to and imports from Western Europe indicates how much the domestic industry's restructuring has affected the U.S. farm machinery trade situation.

Furthermore, for the first time in several years, the domestic under-40 hp (compact) wheel tractor market has begun to contract, resulting in a moderation in the value of imports from Japan (the primary supplier). After increasing 38 percent during first-quarter 1986, the value of farm machinery imports from Japan increased only 1 percent to $133 million during first-quarter 1987.

Any appreciable improvement in the U.S. farm machinery trade balance is unlikely. The prospect of only minimal growth at best in exports to Canada and Australia leaves U.S. farm machinery export growth pegged to foreign agricultural projects in developing countries and trade with Western Europe. Foreign agricultural projects account for a relatively low percentage of the volume and value of U.S. farm machinery exports. Exports to Western Europe are largely influenced by fluctuations in domestic demand for mid-size wheel tractors. Given the current structure of the domestic industry, if domestic demand for foreign-produced wheel tractors (compact or mid-sized) increases, the growth in the value of U.S. farm machinery imports will tend to offset any gains in export growth sustaining the present U.S. farm machinery trade deficit.

ENERGY

U.S. farmers can expect energy prices to edge up only slightly during the remainder of this year, following a 12-percent surge in the first half. Supplies of petroleum and other energy products will remain ample through the 1987 harvest season. Energy expenditures by farmers, which comprise about 4.4 percent of total U.S. energy expenditures, are projected to decline more than 4 percent to $6.6 billion as program acreage cuts more than offset the expected price increase. This would be the

sixth consecutive annual decline in energy expenditures.

Preliminary Department of Energy forecasts indicated that with higher crude oil prices and economic growth at about 3 percent, petroleum consumption would have remained unchanged in the United States in 1987. However, with mid-year economic growth surpassing 3 percent, trends now suggest that consumption may increase in 1987.

U.S. refiners paid between $15 and $18 per barrel for crude oil in the first half of 1987 and are likely to pay $18 to $22 per barrel in the second half if OPEC achieves its production goals. For the year, crude oil acquisition costs are likely to average $18 per barrel, one-quarter over 1986, but still one-third below 1985. Prices for natural gas also increased while coal and electricity prices retreated in the face of plentiful supplies. Slightly higher but less volatile energy prices are likely during the remainder of 1987.

Table 9--Free world demand/supply of crude oil

Item	1985	1986	1987
	Million barrels per day		
Demand:			
United States	16.0	16.3	16.4
Western Europe	11.6	12.0	12.1
Japan	4.3	4.4	4.4
Other	14.4	14.7	14.9
Total	46.3	47.4	47.8
Supply:			
United States	11.2	10.8	10.3
Mexico	2.7	2.4	2.6
North Sea	3.3	3.4	3.3
Other	11.3	11.6	11.8
Non-OPEC total	28.5	28.2	28.0
Saudia Arabia	3.2	4.7	4.2
Kuwait	0.9	1.2	1.0
Venezuela	1.6	1.6	1.5
Indonesia	1.2	1.3	1.2
Other	10.3	10.9	10.7
OPEC total	17.2	19.7	18.6
Total	45.7	47.9	46.6
Net stock withdrawals	.3	-.6	.7
	Billion		
Stocks as of Dec. 31	4.8	5.0	4.7

1987 forecast
Source: Department of Energy.

World Energy Market

World energy production is projected to level off at 311 quadrillion (10^{15}) BTU's in 1987. Energy sources other than petroleum appear to be showing gains in the first half of the year. Energy stocks remain at historically high levels because energy dependent countries last year attempted to protect themselves against the possibility of future price shocks. Oil is the major source of total energy consumed and traded, emphasizing OPEC as the pivotal source of energy in the world and as the swing producer affecting price at the margin. In 1986, oil accounted for an estimated 38 percent of world energy consumption, far surpassing coal at 30 percent, natural gas at 22 percent, hydro at 7 percent, and nuclear at 3 percent. Of total world oil consumption, close to 40 percent was imported, representing about 45 quadrillion BTU's, five times the level of world coal imports and six times natural gas imports.

Petroleum Consumption

Growth in free world petroleum consumption is expected to slow to less than 1 percent this year, curbed by higher crude oil prices, balance of payment problems, and lower than expected economic growth (table 9). Higher prices, current account deficits, and slow growth are likely to persist well into next year. Petroleum consumption in the United States, which accounts for about one quarter of the world's total consumption, is expected to increase slightly. In Japan and Western Europe, although strengthening domestic currencies have helped mitigate the increase in dollar-denominated oil imports, consumption is expected to decline slightly due to slow economic growth and strong conservation measures.

In the United States, the price of oil has been increasing and the rate of growth in imports has declined in the first half of 1987. The negligible increase in most other industrial countries' real oil price over last year may have kept demand more buoyant. In Western Europe, where last year's oil

consumption rose more than 3 percent, consumption may grow more moderately this year. In Japan, real oil import prices have increased only slightly, but economic growth has slowed to about a 2.5-percent annual pace, constraining growth in petroleum demand. The dollar's decline has substantially moderated the increase in real oil prices in newly industrialized countries such as Hong Kong, South Korea, and Taiwan. Hence, above-average economic growth is likely to offset the negative price impact in these countries and boost petroleum consumption in 1987.

Oil Production

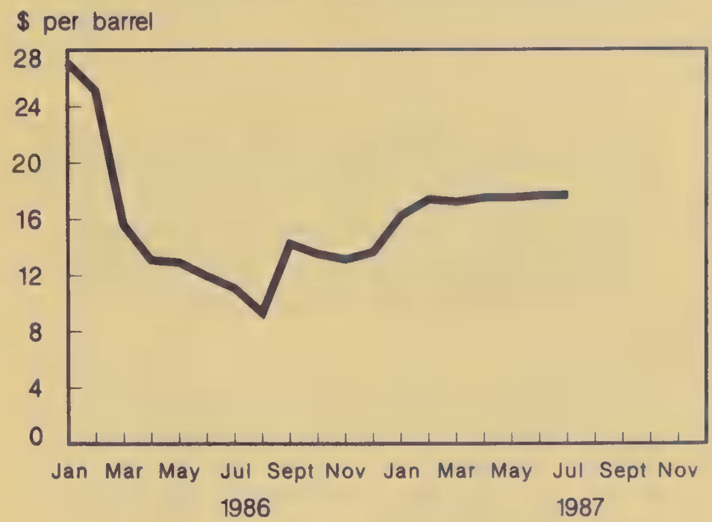
The June 25th agreement by OPEC targets oil production for its members at 16.6 million barrels a day until year's end, down 5 percent from the target level in the first half of 1987. Actual production could be 1 to 1.5 million barrels per day above the ceiling because of disregard by Iraq and other member nations dissatisfied with their quotas. In last year's December agreement, OPEC had decided to set daily quotas of 16.6 million barrels for the third quarter and 18.3 million for the fourth quarter, consistent with estimated demand for OPEC oil of about 18 million barrels per day. It is now estimated that demand for OPEC oil will fall to no more than 17.6 million barrels due to lower than expected growth in consumption and a return to normal stock holding (i.e. lower than last year) in the face of higher-priced oil.

Non-OPEC production declined in 1986, ending 10 years of growth, and is expected to fall another 1 percent this year. The falloff is likely to be mainly in the United States and the North Sea. Non-OPEC developing countries such as Mexico are expected to maintain steady production. Alleviation of technical constraints experienced last year, primarily in the Soviet Union, may help the centrally planned economies to increase their production slightly above 16 million barrels per day this year.

World Oil Prices

With OPEC production off about 2 million barrels per day, average world oil prices (f.o.b. weighted by trade volume) rose 8 percent in the first half of 1987. Since a runup in January, prices have been hovering close to the OPEC target of $18 per barrel. OPEC showed more discipline than anticipated as most members did not sell crude oil below the established target price and buyers turned to inventories.

World Crude Oil Prices



The December agreement by OPEC to limit production reversed the 1986 oil price slide when crude oil prices crashed from $27 to $10 per barrel, curtailing incentives for exploration, reducing oil field maintenance, and slowing output from old fields in many non-OPEC countries. Non-OPEC reserves of crude oil fell nearly 3 percent, mostly in the first quarter of the year, when demand was strongest. While higher prices appear to be encouraging some new exploration, most oil industry analysts suggest that prices ranging from $18 to $22 per barrel will not stop the slide in production that began last year. While a price of $20 per barrel is a major improvement over last year's low price from the oil producer's point of view, the exploration and drilling environment for most U.S. companies and non-OPEC producing countries remains unfavorable in 1987.

Factors which are likely to influence crude oil prices in the latter half of 1987 are:

- The ability of OPEC to restrict the Iraqis from exceeding their production quota of 1.5 million barrels per day. The Iraqis are on the verge of adding another 500,000 barrels of production capacity. The expected completion of a new

pipeline to the Mediterranean Sea through Turkey would raise their delivery capacity to more than 2 million barrels a day.

- The projected demand for OPEC oil, which depends on the health of the world economy and sufficient cooperation between the international oil companies and OPEC to encourage long-term buying contracts and mitigate cheating.

- The behavior of non-OPEC producers such as the Soviet Union, Norway, Egypt, and Mexico, and their willingness to give discounts to attract customers away from OPEC should demand increase.

- The value of the dollar. A further depreciation of the dollar would tend to constrain increases in dollar-denominated oil prices. On the other hand, a strengthening dollar would tend to increase the dollar-denominated price of oil.

- The potential harassment of international oil shipping in the Persian Gulf by Iran.

On balance, the various demand/supply factors, in particular, OPEC production discipline, avoidance of a major economic downturn, and a weak dollar suggest upward pressure on crude oil prices. The upcoming December meeting of OPEC promises to be difficult given the course of the 7-year-old war between Iran and Iraq, long-standing grievances among OPEC members over production quotas, and concern over the fall of the dollar. However, barring unforeseen economic or political developments, OPEC appears capable of championing crude oil prices above $18 per barrel throughout 1987.

U.S. Energy Outlook

Supplies Remain Unchanged, Production Declines, and Imports Increase

Although domestic petroleum production is projected to continue to decline in 1987, U.S. petroleum supplies are expected to remain unchanged from the 1986 level of 16 million barrels per day.

The unprecedented crude oil price drop in 1986 caused the closing of high-cost, low-yield stripper wells and a decline in maintenance and development activity in existing fields. The higher oil prices forecast for 1987 will not noticeably improve this situation, as they come too late and are not large enough to significantly improve drilling and maintenance activity in the short run. As a result, production of crude oil and natural gas liquids is projected to decline again in 1987 by 530,000 barrels per day, a drop of 5 percent. The shortfall will be made up by an increase in imports (table 10).

Net petroleum imports, excluding those for the Strategic Petroleum Reserve (SPR), jumped 26 percent to 5.2 million barrels per day in 1986. In 1987, these imports are expected to rise 7 percent to 5.6 million barrels per day, the highest level in 7 years. The share of total petroleum supplies attributable to net imports (excluding SPR) is

Table 10--U.S. petroleum consumption-supply balance

Item	1984	1985	1986	1987
	Million barrels per day			
Consumption:				
Motor gasoline	6.69	6.83	7.02	7.02
Distillate fuel	2.84	2.87	2.90	2.87
Residual fuel	1.37	1.20	1.40	1.26
Other petroleum 1/	4.82	4.83	4.82	4.98
Total	15.72	15.73	16.14	16.13
Supply:				
Production 2/	11.17	11.26	11.10	10.53
Net imports (excludes SPR)	4.52	4.17	5.24	5.60
Net stock withdrawals	0.08	0.22	-0.21	0.00
Total	15.61	15.65	16.13	16.13
	Percent			
Net imports as a share percent of total supply	29	27	32	35
	Percent change from previous year			
Consumption		0	2.6	0
Production		0.8	-1.4	-5.1
Imports		-7.7	25.6	6.8

SPR = Strategic Petroleum Reserve.
1987 April projections.
1/ Include crude oil product supplied, natural gas liquid (NGL), other hydrocarbons and alcohol, and jet fuel. 2/ Includes domestic crude oil production, NGL, and other petroleum products.

Source: U.S. Department of Energy, Energy Information Administration. Short-Term Energy Outlook, DOE/EIA-0202 (87/2Q). May 1987.

expected to be 35 percent in 1987, up from 32 percent in 1986.

The continued increase in petroleum imports, coupled with a decline in domestic exploration and production activity, has raised some concern about a return to high dependence on foreign oil, especially OPEC oil. OPEC supplied 70 percent of U.S. crude oil and petroleum imports in 1977. During 1983–1985, OPEC's share ranged from 36 to 38 percent, but it rose to 46 percent in 1986. Although OPEC imports declined to 43 percent of the total during the first–quarter of 1987, for the year they are projected to exceed the 1986 level.

Petroleum Consumption Flattens

Total petroleum consumption, rose 2.6 percent (to 16 million barrels per day) in 1986 due to a steep decline in crude oil prices and modest economic growth. April projections indicated petroleum consumption unchanged in 1987, but with economic growth higher than anticipated, consumption may increase slightly this year. Road oil and asphalt consumption is expected to rise as a consequence of the new highway bill. Moreover, jet fuel demand is expected to continue to be strong.

Consumption by Type of Fuel

Motor Gasoline. Gasoline consumption in 1986 rose primarily because lower gasoline prices boosted travel. In 1987, prices are rising and, as a result, travel is increasing at a 2–percent rate compared with 5 percent in 1986. The modest increase in travel activity is, however, expected to be offset by improvements in automobile efficiency as older cars are displaced by new, more fuel–efficient cars. Consequently, gasoline consumption is expected to remain stable in 1987 and average 7 million barrels per day through mid–1988.

Distillate Fuel Oil. Consumption of distillate fuel oil (which consists of diesel fuel and heating oil) is projected to remain at 2.9 million barrels per day in 1987, almost the same as in 1986. A projected 3–percent increase in industrial production should stimulate the consumption of diesel fuel by heavy– and medium–weight trucks. However, the residential and commercial consumption of heating oil, for home heating and as boiler fuel, is projected to fall in 1987 due to higher prices, conservation, and lack of penetration into the new housing market, offsetting the expected increase in diesel fuel consumption.

Residual Fuel Oil. Residual fuel oil consumption jumped 17 percent in 1986 to 1.4 million barrels per day, reversing a long–term declining trend dating back to 1977. As residual fuel oil prices rose in the 1970's, industrial plants and electric utilities installed additional gas– and coal–fired boilers, causing residual fuel oil use to decline. With residual fuel oil prices off 44 percent in 1986, many electric utilities switched back to residual fuel oil from natural gas.

In 1987, consumption of residual fuel oil is projected to be 10 percent lower (1.3 million barrels per day) than in 1986, due mainly to a projected 18–percent increase in its price. In the utility sector, demand is expected to be dampened by an increase in coal–fired and nuclear electric generating capacity. Nonutility demand, which was flat in 1986, is expected to decline 7 percent in 1987 due mainly to price increases.

Natural Gas Consumption To Rise

Total natural gas consumption in 1987 is expected to be more than 16 trillion cubic feet, up 2 percent from 1986. Residential consumption is projected to rise slightly above the 1986 level. An increase in the number of new single–family homes equipped with natural gas furnaces is expected to bolster future natural gas demand.

Commercial consumption, which is more price–sensitive than residential consumption, is projected to increase 3 percent from 1986, as rising oil prices will induce some switching from oil back to natural gas. Natural gas consumption by electric utilities is expected to remain nearly flat between 1986 and 1987. The oil and natural gas share of total electric utility fuel requirements is projected to decline as new nuclear and coal–fired capacity is brought on line.

Natural gas production declined 2.5 percent to about 16 trillion cubic feet between 1985 and 1986. In 1987, production is projected to increase slightly to 16.1 trillion

cubic feet. Natural gas imports, mostly from Canada, are projected to increase 27 percent to 890 billion cubic feet, reaching the same level as in 1985. Increased production and imports are attributable to growth in the industrial sector as well as expected switching back to natural gas.

Electricity Demand Up

Electricity consumption in 1987 is projected to increase more than 2 percent from last year, to 2,545 billion kilowatt hours. In 1986, the growth rate was less than 1 percent. Stronger demand is anticipated due to lower real electricity prices and continued growth in personal income.

Net electricity imports, primarily from Canada and some from Mexico, have been rising since the late 1970's. Total net imports are expected to reach 45 billion kilowatt hours in 1987, 1 billion above the 1986 level. This increase stems mainly from the recently completed and now fully operational transmission facility between Quebec, Canada and the New England States.

Energy in the Farm Sector

The U.S. agriculture sector's energy supply and price expectations largely reflect U.S. market conditions which, in turn, mirror world markets. In 1987, farmers can expect adequate supplies of diesel fuel, gasoline, and LP gas. The farm fuel price situation this year is different from 1986 as prices have risen throughout the year. Average annual prices for 1987 are expected to be slightly higher than 1986, but still much lower than those in 1985.

Expenditures and Use Continue To Fall

In 1986, farm energy expenditures (gasoline, diesel, LP gas, and electricity) dropped nearly 21 percent to 6.9 billion. Expenditures in 1987 are projected to decline 4 to 6 percent. This is the sixth consecutive annual decline in farm energy expenditures since the 1981 peak, and is due to relatively low prices, an 8-percent (23 million acres) reduction in planted acreage because of farmers' participation in various commodity programs, and energy conservation efforts.

Utilization

Although farm energy use constitutes only about 3 percent of total U.S. energy consumption, energy is a very critical agricultural input, as farm operations are highly mechanized and harvesting and planting have to be completed in a timely manner.

In 1986, on-farm gasoline and LP gas use declined 5 and 22 percent respectively, whereas diesel fuel use remained unchanged (table 11). Diesel fuel use, however, continues to increase relative to gasoline as older, gasoline-powered tractors and engines are being replaced with diesel-power. Gasoline and diesel fuel use in 1987 is projected to decline 9.5 percent.

Prices

In 1986, following the unprecedented plunge in world oil prices, farm gasoline, diesel fuel, and LP gas prices fell 23, 29, and 8 percent respectively (table 12). In 1987, farm fuel prices have risen, however, the average prices for the year are expected to be slightly higher than last year. USDA's fuels and energy index in July 1987 rose to 170 (1977=100), up 18 points (12 percent) from a year earlier. The greatest contributor to the increase was bulk-delivered gasoline, which rose 11 cents since January, to 96 cents per gallon. Prices for diesel fuel rose 5 cents per gallon.

Farm Energy Expenditures

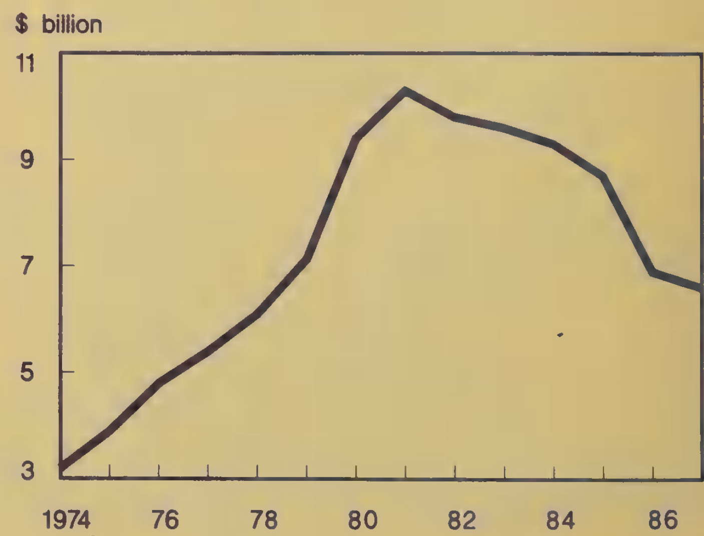


Table 11--Farm fuel use

Year	Gasoline	Diesel	LP gas
	Billion gallons		
1974	3.7	2.6	1.4
1975	4.5	2.4	1.0
1976	3.9	2.8	1.2
1977	3.8	2.9	1.1
1978	3.6	3.2	1.3
1979	3.4	3.2	1.1
1980	3.0	3.1	1.1
1981	2.7	2.9	1.0
1982	2.4	3.0	1.1
1983	2.3	3.0	0.9
1984	2.1	3.0	0.9
1985	1.9	2.9	0.9
1986	1.8	2.9	0.7

Table 12--Average U.S. farm fuel prices 1/

Year	Gasoline	Diesel	LP gas
	Dollars per gallon 2/		
1977	.57	.45	.39
1978	.60	.46	.40
1979	.80	.68	.44
1980	1.15	.99	.62
1981	1.29	1.16	.70
1982	1.23	1.11	.71
1983	1.18	1.00	.77
1984	1.16	1.00	.76
1985	1.15	.97	.73
1986	.89	.69	.67
1987			
January	.85	.67	.62
April	.90	.70	.60
July	.96	.72	.56

1/ Based on surveys of farm supply dealers conducted by the National Agricultural Statistics Service, USDA. 2/ Bulk delivered.

IMPLICATIONS OF NOT HAVING LEADED GASOLINE FOR FARM EQUIPMENT

by
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Office of Energy

Abstract: Leaded gasoline is no longer being carried by some fuel suppliers and may not be readily available within 5 years. Although diesel engines provide the principal source of power for tillage, planting, and harvesting on farms, millions of gasoline engines are in use in tractors, combines, trucks, and specialized equipment. Many of these engines risk excessive valve seat wear if fueled with unleaded gasoline. Farmers should continue to use leaded gasoline as long as it is available, install hard valve seats when engines are overhauled, and explore other options for reducing risks when using unleaded gasoline.

Key words: Leaded gasoline, tractors, combines, farm equipment, EPA

Introduction

Although diesel power has largely replaced gasoline engines for major tillage, planting, and harvesting operations, and manufacturers have stopped making gasoline-powered tractors and combines (table 13), millions of engines still in use on U.S. farms were designed to burn leaded gasoline. These engines are found in tractors and combines, as well as trucks and a variety of specialized equipment. However, because lead from gasoline poses a significant health risk, the Environmental Protection Agency (EPA) gradually has been reducing the amount of lead in gasoline. The amount permitted in leaded gasoline has been phased down from about 2.5 grams per gallon in the early seventies to 0.1 gram per gallon now. Due to special provisions in EPA's regulations, many refiners are still able to use more than 0.1 gram per gallon (the average is now about 0.2 gram). But, by January 1, 1988, no refiner will be permitted to use more than 0.1 gram of lead per gallon.

Unleaded gasoline accounts for about 75 percent of all gasoline sold in the United

Table 13--Year when major tractor and combine manufacturers stopped manufacturing gasoline-powered units

Manufacturer	Tractors	Combines
International Harvester/ Farmall/McCormick	1978	1976
John Deere	1974	1974
Ford	1984	None
Allis Chalmers (Gleaner combines)	1976	1981
J.I. Case	1972	1970
Massey Ferguson	1979	1977
Oliver and Minneapolis Moline	1970	Late 1960's
White	1975	None

States, although the majority of gasoline sold for farm use still contains lead. By the end of 1987, the total amount of lead used in all gasoline will have been reduced by about 99 percent.

In 1985, EPA raised the possibility of completely banning leaded gasoline as early as 1988. Many questions were raised about whether low-lead and unleaded gasoline would damage farm engines. Most automobiles and light trucks built since the early seventies have been designed to use unleaded gasoline. Over time, increasingly larger trucks also have been built for unleaded gasoline. However, most gasoline engines on farms were built for leaded gasoline.

Congress included a provision in the 1985 Food Security Act requiring EPA and the Department of Agriculture (USDA) to study the effects of low-lead gasoline, unleaded gasoline, and non-lead additives on farm engines. The study, which was completed in April, revealed that most of the engines tested would be damaged if operated on unleaded gasoline. EPA held public hearings on the study in June and must report to Congress this fall on the need for leaded gasoline for farm equipment. EPA does not now plan to ban sales of leaded gasoline, which is beginning to disappear anyway in some areas because of market forces.

Engine Wear and the Role of Lead

Lead originally was put into gasoline because it was an inexpensive way to raise octane ratings. However, lead in gasoline also forms deposits on exhaust valve seats and reduces valve seat wear caused by the constant striking action of the valves. Until very recently, lead content was so high that valve rotators were installed to scuff off excess lead deposits. When unleaded gasoline is used, the lead deposits are absent and valve seats are vulnerable to excessive wear, especially in engines built with valve rotators. However, not all engines are vulnerable.

The following factors appear to increase an engine's vulnerability:

- Ordinary cast-iron exhaust valve seats.
- Valve rotators.
- High engine speeds (revolutions per minute).
- Heavy engine loads.
- Lean carburetor settings (high air-fuel ratios).
- High engine temperatures.

High engine temperatures may be caused by high engine speeds and heavy loads, lean carburetor settings, improperly maintained cooling systems, and so forth.

Engines that have high-quality steel alloy exhaust valve seat inserts are not likely to experience excessive valve seat wear regardless of the type of gasoline used, or how the engine is used. Many tractor, combine, and truck engines were built with ordinary cast iron valve seats, yet many others were built with hard seats.

Rebuilt engines may not have the same type of valve seats as those installed when the engines were manufactured. Many rebuilders have routinely used ordinary cast iron valve seat inserts regardless of original equipment specifications. Other rebuilders routinely install hard valve seats.

Two-cycle engines are not affected by unleaded gasoline because they do not have exhaust valve seats. Small four-cycle engines used in lawn mowers, garden tractors, and similar equipment generally have been built with hardened exhaust-valve seats for at least 10 years and do not pose a significant problem overall.

The EPA-USDA Study

The joint EPA-USDA study included laboratory testing of engines, a survey of farmers to find out how many gasoline engines they have and how much and hard they are used, and a survey of tractor dismantling/used-parts establishments to learn what types of valve seats presently are found in gasoline tractors.

The surveys showed that in 1985, farmers operated some 1.8 million gasoline-powered tractors (2.6 million are diesel powered), 271,000 gasoline-powered combines, and 750,000 gasoline-powered trucks larger than one-ton capacity (table 14). The gasoline tractors averaged 26 years of age and 40 horsepower, and were used an average of 250 hours in 1985. The largest number of gasoline-powered tractors was found in the Corn Belt, Lake States, Northeast, and Appalachia. About 42 percent were used exclusively in light-duty tasks, while the others received some medium- or heavy-duty use. On average, larger tractors are used more hours and in heavier-duty tasks than smaller tractors. The survey of tractor dismantling/used-parts establishments revealed that overall, about two-thirds of gasoline tractors had ordinary cast-iron exhaust valve seats in 1986.

Gasoline-powered combines averaged 19 years of age and were used to harvest an average of 220 acres of grain in 1985. Trucks also averaged 19 years of age and were driven an average of 3,800 miles in 1985. The amount of time gasoline-powered tractors, combines, and trucks were used varied widely (table 15).

Tests were performed on the following seven engines:

- John Deere B tractor, 190 cubic inch displacement (CID), 24 horsepower (HP) at 1,250 revolutions per minute (RPM), representative of many of the 2-cylinder engines built by John Deere.

- Ford 8N tractor, 4-cylinders, 120 CID, 23 HP at 2,000 RPM. Reportedly the most commonly found model of tractor (gasoline or diesel) in existence today.

- Farmall H tractor, 4-cylinders, 152 CID, 24 HP at 1,650 RPM.

- International Harvester 240 tractor, 4-cylinders, 123 CID, 27 HP at 2,000 RPM. Representative of many International Harvester engines less than 150 CID sold until 1979.

Table 14--Number of gasoline-powered tractors, combines, and trucks larger than one ton on farms, by region, 1985

Region/State	Tractors	Combines	Trucks
	Thousand		
Northeast (CT, DE, ME, MD, MA, NH, NJ, NY, PA, RI and VT)	207	26	62
Appalachia (KY, NC, TN, VA, and WV)	273	16	97
Southeast (AL, FL, GA, and SC)	38	7	39
Delta (AR, MS, and LA)	23	4	15
Southern Plains (OK and TX)	72	15	44
Lake States (MI, MN, and WI)	353	49	77
Corn Belt (IL, IN, IA, MO, and OH)	473	82	149
Northern Plains (KS, NE, ND, and SD)	171	51	173
Mountain (AZ, CO, ID, MT, NV, NM, UT, and WY)	90	12	81
Pacific (CA, OR, and WA)	104	10	54
United States	1,804	272	1/ 800

1/ Includes some one-ton trucks.

Table 15--Distribution of gasoline-powered tractors, combines, and trucks larger than one ton, by amount of use, 1985

Tractors			Combines		Trucks	
Annual hours of use	Percent of tractors	Average horsepower	Annual acres harvested	Percent of combines	Annual miles driven	Percent of trucks
20-49	12	31	1-99	38	0-1,000	35
50-99	18	34	100-199	26	1,001-2,000	20
100-149	18	38	200-299	12	2,001-3,000	11
150-249	20	43	300-399	9	3,001-4,000	6
250-499	17	46	400-499	5	4,001-5,000	10
500-749	8	49	500-999	8	5,001-10,000	13
750-1,499	5	49	1,000 or more	2	10,001-20,000	4
1,500 or more	2	54	NA	NA	20,001 or more	1
All	100	40	All	100	All	100

NA = not applicable.

Source: (1).

- John Deere 303 CID, 6-cylinder combine engine, 80 HP at 2,500 RPM. Representative of engines used in tractors, combines, and other equipment between 1960 and 1974.

- General Motors 292 CID, 6-cylinder truck engine, 120 HP at 4,000 RPM. Representative of pre-1974 engines used in light trucks and agricultural equipment.

- General Motors 454 CID, 8-cylinder recreational-vehicle engine, 210 HP at 4,000 RPM. Representative of 1982 model production.

The engines represented a wide range of types, ages, and sizes of gasoline engines used in farm equipment. All but the Ford 8N, Farmall H, and GM 454 CID were originally equipped with ordinary cast iron valve seats. The Farmall H was equipped with harder "gray iron" valve seats that are no longer available and the GM 454 was equipped with induction-hardened cast iron valve seats that are still in use today. Since ordinary cast iron valve seat inserts are readily available when rebuilding the Ford 8N and Farmall H tractors, they were tested with these inserts. The GM 454 CID was tested with its original-equipment induction-hardened valve seats.

Engines were tested using a combination of speeds and loads that are representative of the use these engines typically experience. The engines were tested on leaded (1.1 grams per gallon), low-lead (0.1 gram per gallon), and unleaded gasoline, and two non-lead substitute additives. Each engine was operated up to 200 hours on each type of fuel.

All the engines operated satisfactorily on leaded and low-lead gasoline. However, all but two of them failed on unleaded. The John Deere B and Farmall H were the two that showed no problems with unleaded gasoline. They are both relatively slow-speed engines that do not use valve rotators. The engines that failed were operated at 2,000 to 3,600 RPM and all had valve rotators. One of the valve seats in the 292 CID truck engine was completely worn out in just 71 hours, which would represent 3,500 miles of driving at an average speed of 50 miles per hour.

Two of the supposedly most promising non-lead gasoline additives were tested. The manufacturers requested their products be included in the test. One additive,

manufactured by E.I. Du Pont De Nemours & Company, was only partially effective in reducing valve seat wear. It also produced engine deposits that threatened to cause engine damage, and elevated the level of phosphorus in the lubricating oil. The other additive, manufactured by The Lubrizol Corporation, also was only partially effective in reducing engine wear when tested at the manufacturer's suggested concentration. However, the additive stopped valve-seat wear when the concentration was quadrupled. This additive also produced deposits in the engine and lubricating oil. The implications of the deposits are not known. The additives are marketed by other firms under a variety of brand names.

The study indicated that farm engines could be significantly damaged if leaded gasoline were not available. Also, non-lead additives have not yet proven to be a satisfactory substitute for lead.

The following tractors were originally built with hard exhaust valve seats and, therefore, are not likely to experience excessive valve seat wear regardless of the type of gasoline used, or how the engine is used (unless they have been rebuilt with ordinary cast iron exhaust valve seats):

- All Fords.
- Farmall/International Harvester H, M, Super H, Super M, W-4, W-6, W-9, 300, 350, 400, 450, 454, 464, 544, 574, and 674 (4-cylinder engines).
- All Farmall/International Harvester 6-cylinder engines.
- Most Minneapolis Molines.
- Many J.I. Cases.

Tractors built with ordinary cast iron exhaust valve seats that are vulnerable to excessive wear with unleaded gasoline include:

- All John Deeres except those having cylinder heads built for LP engines.
- Farmall/International Harvester Cub, A, B, C, Super A, Super C, 100, 130, 140, 200, 230, 240, 330, 340, 404, 424, 444, and 504 (4-cylinder engines).

Farmers should check with their dealers for specific information on their equipment.

What to Expect

It now appears that EPA will not ban sales of leaded gasoline any time soon. However, several major oil companies have already announced plans to discontinue sales of leaded gasoline in some areas, preferring instead to sell a third grade of unleaded gasoline (e.g. 89 octane). As the volume of leaded gasoline declines, more companies will follow suit. Smaller refineries, independent gasoline distributors, and farmer co-operatives are expected to continue offering leaded gasoline as long as they can obtain it from interstate pipelines. Technically, it is possible for farmer co-operatives and other gasoline distributors to produce their own leaded gasoline, but economic considerations will be a deciding factor.

In the refinery, it is more expensive to manufacture an 89-octane leaded gasoline containing only 0.1 gram of lead per gallon than to manufacture an 87-octane unleaded gasoline. The retail price of leaded gasoline is expected to rise above the price of unleaded regular soon (it already has at wholesale) and this will hasten the decline in the availability of leaded gasoline. Small-scale blending of lead into unleaded gasoline at terminals would make the cost of producing leaded gasoline even higher. When sales of leaded gasoline drop below 10 to 15 percent of total sales, oil companies may discontinue sales of the product. No one knows if and when leaded gasoline will completely disappear from the market, although there is a good chance it could happen within 5 years.

Within 1 to 2 years, some farmers, boaters, recreation-vehicle owners, and others who have older engines that are operated under heavy-duty conditions could have some difficulty finding leaded gasoline, especially in nonfarm areas of the United States.

Farmers should continue to use leaded gasoline in engines designed for it as long as it is available. Farmers also should check with their oil companies to be sure that leaded gasoline actually contains about 0.1 gram of

lead per gallon. Some leaded gasoline sold today contains very little lead because there is no regulation on the minimum content.

Farmers need to insist that high--quality steel valve-seat inserts (e.g. stellite) be installed whenever a gasoline engine is overhauled so that the engines may be operated with unleaded gasoline.

If leaded gasoline disappears from the market, it probably will be safe to use unleaded gasoline that has sufficient octane if an engine:

- Has hard steel valve seats.
- Has ordinary cast iron valve seats but is not used for heavy duty operations. Farmers should avoid high RPM, high engine load conditions, and other conditions that may cause the engine to run hot and lean.
- Has ordinary cast iron valve seats but is a low-RPM engine (e.g. less than 1,700 RPM).

If an engine is thought to be vulnerable to excessive valve seat wear with unleaded gasoline, and leaded gasoline is not available, options include:

- Using diesel-powered tractors for heavy-duty tasks such as plowing, disking, etc.
- Reducing heavy loads on an engine by shifting down and reducing engine speed (i.e. take longer to do tasks that put a heavy strain on an engine).
- Setting carburetors on the rich side (lower the air-fuel ratio).
- Keeping engines, especially cooling systems, in good repair and free of attachments that might trap heat around them.
- Using a non-lead additive to protect the valve seats.
- Doing a valve overhaul sooner than expected. If the engine has valve rotators, have them locked or removed. High-quality valve seats may add about $5 per cylinder to the total cost of rebuilding an engine if the valve seats are already being replaced. The total cost of a valve overhaul can run $500 to $1,500 depending on the engine and how much of the repair work is performed by the farmer.

Since the threat of engine damage concerns many people besides farmers, there is reason to believe that leaded gasoline will be available as a specialty fuel for several years. There also is a good chance that effective non-lead additives will be available. In either case, though, the cost of gasoline for engines that need special valve-seat protection will be higher than leaded gasoline is today.

References

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PESTICIDES

Demand

Total 1987 farm pesticide use on major field crops is projected to be 430 million pounds, active ingredients (a.i.), down from 475 million pounds in 1986 (table 16). Planted acreage for the 10 major field crops declined from 267 million in 1986 to 246 million this year.

The largest decline--10.6 million acres--was for corn, the major user of herbicides and insecticides. Wheat acreage is down 6.9 million, soybeans 2.8 million, and grain sorghum 3.6 million acres. Barley and oat acreage is up about 1.2 million and cotton 400,000. Peanut, tobacco, and rice acreage is unchanged from 1986.

Prices

Average farm-level herbicide prices remained stable at $4.05 per pound (a.i.) between 1986 and 1987 (table 17). The price of alachlor, a major corn and soybean herbicide, decreased 5 percent because of a cash rebate program. However, atrazine (corn) and 2,4-D (wheat) prices increased 3 and 8 percent. Even with the price increases, atrazine and 2,4-D remain low cost-per-acre treatments for weed control.

Farm-level insecticide prices are projected to be down slightly this year, led by decreases of 7 percent for carbofuran and 5 percent for the synthetic pyrethroids. Methyl parathion prices are up about 3 percent in 1987. Methyl parathion is used extensively to control boll weevils in cotton production. Boll weevil populations were large last fall and the mild winter resulted in a high survival rate requiring above average insecticide use to control damage. For example, Mississippi farmers have sprayed from 3 to 6 times this year to control boll weevils.

Regulatory Actions

The Environmental Protection Agency (EPA) is initiating a Special Review of the ethylene bisdithiocarbamate (EBDC) fungicides. The EBDC fungicides important in agricultural production include maneb, mancozeb, zineb, and metiram. They are

Table 16--Projected pesticide use on major U.S. field crops

Crops	June 1, 1987 planted acreage	Herbicides	Insecticides	Fungicides
	Million	Million pounds (active ingredients)		
Row:				
Corn	66.0	196	24.3	0.06
Cotton	10.4	16	15.5	.16
Grain sorghum	11.8	11	1.8	0
Peanuts	1.5	6	1.2	5.57
Soybeans	58.7	104	9.1	.06
Tobacco	.6	1	2.3	.30
Total	149.0	334	54.2	6.15
Small grains:				
Barley and oats	29.0	7	.2	0
Rice	2.3	10	.4	.06
Wheat	65.2	14	1.8	.75
Total	96.5	31	2.4	.81
Total	245.5	365	56.6	6.96

Table 17--U.S. average farm retail pesticide prices

Pesticide 1/	1985	1986	1987	Change 1986-87
	Dollars per pound 5/			Percent
Herbicides:				
Alachlor	5.15	5.10	4.84	-5.1
Atrazine	2.04	2.14	2.20	2.8
Butylate	3.13	3.10	3.04	-1.9
Cyanazine	4.55	4.55	4.62	1.5
Metolachlor	6.09	6.05	6.03	-.3
Trifluralin	6.43	6.25	6.30	.8
2,4-D	2.38	2.26	2.44	8.0
Composite 2/	4.06	4.05	4.05	0
Insecticides:				
Carbaryl	3.84	3.91	3.90	-.3
Carbofuran	10.29	10.27	9.57	-6.8
Chlorpyrifos	8.23	8.30	8.25	-.6
Fonofos	8.85	8.82	8.70	-1.4
Methyl parathion 3/	2.75	2.74	2.82	2.9
Phorate	6.57	6.54	6.59	.8
Synthetic pyrethriods 4/	54.40	51.20	48.80	-4.7
Terbufos	9.80	9.79	9.79	0
Composite 2/	10.49	10.27	10.25	-.2

1/ Based on surveys of farm supply dealers conducted by the National Agricultural Statistics Service, USDA. 1985 prices are a simple average of March and May prices. 1986 and 1987 are April prices. 2/ Includes above materials and other major materials not listed. 3/ Fred Cooke, Mississippi Agricultural Experiment Station. 4/ Average of fenvalerate and permethrin prices based on 2.5 pounds active ingredient per gallon. 5/ Active ingredients.

Table 18--Annual agricultural use of selected EBDC fungicides, 1983-85

Fungicide/crop	Acres treated	per year 1/	Pounds used	Times applied
	Percent	1,000	1,000	Number
Maneb:				
Apples	8	40	650	5.2
Potatoes	32	400	1,200	2.4
Tomatoes	20	100	1,000	9.0
Grapes	5	40	80	1.0
Sweet corn	15	95	600	4.7
Onions	80	100	300	3.0
Snapbeans	10	30	125	2.7
Wheat	*	75	100	1.1
Sugarbeets	2	15	40	2.0
Lettuce	30	80	250	2.0
Almonds	8	30	80	2.0
Pears	*	3	25	1.0
Peanuts	6	90	375	1.0
Beans and peas	3	35	60	2.1
Peaches	*	3	20	1.0
Total			5,005	
Maneozeb:				
Apples	35	200	3,400	4.1
Potatoes	30	350	1,800	2.9
Tomatoes	40	160	1,100	2.8
Grapes	8	60	825	3.2
Sweet corn	25	150	620	4.1
Onions	80	100	580	3.6
Snapbeans	15	50	280	3.2
Cole crops	20	50	240	2.2
Wheat	*	180	220	1.0
Sugarbeets	5	50	190	2.1
Lettuce	25	60	155	1.4
Almonds	8	30	150	1.0
Carrots	30	25	120	2.4
Pears	12	10	90	2.0
Peanuts	1	15	55	8.0
Beans and peas	1	10	20	1.5
Total			9,845	
Zineb:				
Citrus	6	110	620	1.1
Apples	9	24	396	3.8
Pears	15	12	73	1.0
Spinach	17	5	50	5.0
Mushrooms	NA	NA	25	NA
Plums	*	2	21	3.0
Tobacco	*	5	10	1.0
Peaches	*	1	14	1.0

broad-spectrum fungicides used to prevent crop damage by fungi and to protect harvested crops from deteriorating in storage.

The individual EBDC fungicides may be used on the same acreage and applied several times during the growing season. Therefore, the data presented in table 18 for individual fungicides cannot be added to obtain the total

Table 18--Annual agricultural use of selected EBDC fungicides, 1983-85 (cont.)

Fungicide/crop	Acres treated	per year 1/	Pounds used	Times applied
	Percent	1,000	1,000	Number
Onions	*	1	2	1.0
Dry beans	*	1	2	1.0
Total			1,213	
Metiram:				
Apples	10	50	1,500	7.0
Potatoes	1	15	150	4.3
Sweet corn	1	1	2	1.0
Tomatoes	1	4	8	1.0
Total			1,660	

* Less than 1 percent.
NA = Not applicable.
1/ Acres treated are not additive because the same acreage may be treated with more than one fungicide product.

Source: Economic Analysis Branch, Environmental Protection Agency.

acreage to which EBDC fungicides were applied. For example, maneb and mancozeb are each used on 80 percent of the onion acreage, or 160 percent of the acreage if each was used alone. EBDC fungicides are of major importance in the production of apples, potatoes, and tomatoes. They are also important in the production of several other vegetable, fruit, and specialty crops.

EPA has cited the potential risk of cancer to humans from dietary exposure and of adverse thyroid effects and birth defects to workers who mix, load, and apply EBDC fungicides. The cause is a common contaminant in all EBDC fungicides: ethylenethiourea (ETU). Studies in laboratory animals have shown that ETU causes tumors, adverse effects on the thyroid, and birth defects.

Following is a summary of other Special Reviews being conducted by the EPA for pesticides used in agriculture. The public is informed of the initiation of a Special Review with the publication of the risk analyses, Position Document (PD) 1. EPA presents its proposed regulatory decision in PD 2/3. After a period of public comment and scientific review, a final position document (PD 4) is published, delineating EPA's actual regulatory decision.

Special Reviews by EPA

Common Name	*Category*	*Major Use*	*Possible Risk*	*Status*
Alachlor	Herbicide	Corn, soybeans, peanuts	Carcinogen	PD 4, fall 1987
Aldicarb	Insecticide, nematicide	Peanuts, potatoes, cotton, citrus	Acute toxicity	PD 2/3, fall 1987
Amitrole	Herbicide	Non-crop areas	Carcinogen	PD 2/3, FY 1988
Cadmium	Fungicide	Golf course	Carcinogen, birth defects, fetal death	PD 4, fall 1987
Captafol	Fungicide	Apples, citrus, potatoes, tomatoes	Carcinogen	PD 2/3, fall 1987
Carbofuran	Insecticide	Corn, peanuts, sorghum, sunflowers	Wildlife, bald eagles	PD 2/3, fall 1987
Cyanazine	Herbicide	Corn, sorghum, cotton	Birth defects	PD 4, fall 1987
Dinocap	Fungicide	Apples	Birth defects	PD 4, fall 1987
Linuron	Herbicide	Corn, fruits, vegetables	Carcinogen	PD 2/3, fall 1987
Parathion	Insecticide	Wheat, sorghum, fruits	Acute human toxicity	PD 1/2/3, fall 1987

U.S. Pesticide Trade Situation

by

Stan Daberkow and John Parks

As a major producer and consumer of agricultural pesticides, the United States has established a large and growing trade in herbicides, insecticides, fungicides, and other pesticide materials. The value of pesticide exports grew from $1.2 billion in 1980 to $1.4 billion in 1986 and peaked in 1984 at $1.5 billion (table 19). In 1986, technical material (active ingredients not formulated into retail products) exports accounted for about 54 percent of the total, whereas formulated products (active ingredients combined with carriers, diluents, and other inert materials) made up the remainder. For many pesticides, it is more economical to ship the technical material than the formulated product, especially if the importing country has adequate facilities for packaging and mixing.

In 1986, herbicides constituted nearly 44 percent ($625 million) of U.S. pesticide exports, insecticides 36 percent ($513 million), and fungicides 16 percent ($222 million). Of the three major categories, herbicides grew the fastest (29 percent) between 1980 and 1986, followed by fungicides (14 percent) and insecticides (13 percent). The fastest growing sub-categories were miscellaneous formulated insecticides (135 percent) and technical herbicide materials (51 percent). Chlorinated hydrocarbon insecticides, which include DDT, have shown the greatest decline since 1980;

Table 19--U.S. pesticide exports and imports 1/

Item	1980	1981	1982	1983	1984	1985	1986
				Million dollars			
Exports:							
Technical material							
Insecticides							
Organophosphorus	117	109	120	120	129	110	108
Aldrin-toxaphene	17	18	20	19	22	25	18
Polychlorinated	213	214	194	169	225	212	231
Herbicides	195	210	200	235	302	291	295
Fungicides	108	103	112	100	108	100	100
Fumigants	13	12	10	12	11	15	11
Total	663	666	656	655	797	753	763
Formulated product							
Insecticides							
Chlorinated-hydrocarbon	18	12	5	6	2	1	1
Methyl parathion	51	41	60	62	44	49	61
Others 2/	40	52	69	75	101	100	94
Herbicides	291	290	309	358	405	331	330
Fungicides	86	79	109	71	91	84	122
Other pesticides 2/	45	51	37	41	46	37	42
Pesticides,non-agri use	16	15	12	12	12	7	10
Total	547	540	601	625	701	609	660
All materials							
Insecticides	456	446	468	451	523	497	513
Herbicides	486	500	509	593	707	622	625
Fungicides	194	182	221	171	199	184	222
Others	74	78	59	65	69	59	63
Total exports	1,210	1,204	1,257	1,280	1,497	1,363	1,424
Imports:							
Technical material	259	294	276	245	310	366	330
Formulated product	49	44	44	58	65	83	93
Total imports	308	338	320	303	375	449	423
Trade balance	902	866	937	977	1,123	911	1001

1/ Totals may not add due to rounding. 2/ Those not specifically provided for.

Source: U.S. Bureau of the Census.

falling from $18 million to near $1 million in 1986. The last U.S. DDT production site closed in 1983, which, along with increased foreign production of related products, contributed to the falloff in chlorinated hydrocarbon exports. The aldrin-toxaphene insecticide category, which is no longer registered in the United States for use on major crops, had increased until 1986.

Pesticide imports also grew between 1980 and 1986, peaking in 1985 at $449 million. As with exports, imports of technical material greatly surpass those of formulated products. Since transportation charges and tariffs are applied on a poundage basis, it is often cheaper to import the higher-valued technical material rather than the formulated product. However, imports of formulated products grew 90 percent in value over the last 6 years, while those of technical materials grew only 27 percent. Since 1980, the U.S. trade balance in pesticides has generally increased, peaking in 1984 at $1.1 billion but falling to $1 billion in 1986.

Between 1982 and 1986, the United States exported pesticides to 144 countries. Over one-half of the export value was to Western Europe and Asia, countries that compete with the United States in agricultural trade. Over the last 5 years, Western Europe received over one-third of our pesticide exports, while Asia took slightly over 23 percent (table 20). Japan, Switzerland, and West Germany, as well as the transshipment countries of Belgium-Luxembourg and the Netherlands, were the major recipients of U.S. pesticides. North, Central, and South American countries purchased another one-third of U.S. exports, with Canada and Brazil the major markets.

In 1982, Canada was the leading U.S. market (12.9 percent), followed by Japan (8.2), Switzerland (9.3), Belgium–Luxembourg (7.6), and West Germany (5.9). By 1986, the top–five ranking changed to Belgium–Luxembourg (10.6 percent), Japan (10.4), Canada (9.3), the Netherlands (6.9), and Brazil (5.8). Rapidly growing markets (or points–of–entry) between 1982 and 1986 were Belgium–Luxembourg, the Netherlands, Brazil, and Japan, whereas Canada, West Germany, and Switzerland received smaller shares of U.S. exports.

The United States imported pesticides from 46 countries during 1982–86. The largest source of pesticide imports was Western Europe, which supplied 80 percent ($221 million) of the total in 1982, but whose share dropped to 73 percent ($242 million) in 1986 (table 21). In 1982, Switzerland supplied 30 percent of all U.S. imports ($82 million), followed by West Germany at 21 percent ($58 million), and the United Kingdom and Italy with around 6.5 percent each ($18 million). West Germany was the largest supplier of pesticides to the United States in 1986 with a 16 percent share ($54 million). The United Kingdom was the second largest supplier at 12.5 percent ($41 million), followed by Italy at 11 percent ($36 million), and Switzerland, which fell to fourth at 8.7 percent ($29 million).

Japan, the largest Asian source of U.S. imports began with 10 percent of the total in 1982 but ended 1986 with only 4 percent. At the same time, Israel, the second largest Asian supplier with 3 percent ($8 million) in 1982, became the largest Asian exporter to the United States at 5.6 percent ($19 million) in 1986.

Brazil has become another major supplier of pesticides to the United States. In 1982, it accounted for 2 percent ($6 million) of U.S. imports, but its share jumped to 13 percent

Table 20—U.S. pesticide exports, region and country share 1/

Region/Country	1982	1983	1984	1985	1986
			Percent		
Africa:					
Republic of South Africa	1.6	1.3	1.3	1.4	1.7
Other	1.7	1.8	2.5	1.4	2.2
Total	3.3	3.1	3.8	2.9	3.8
North and Central America:					
Canada	12.9	13.9	13.2	12.7	9.3
Costa Rica	1.6	1.5	1.1	1.5	1.4
Mexico	2.2	2.1	2.3	3.4	3.0
Other	5.7	5.1	5.4	4.1	3.8
Total	22.4	22.6	22.0	21.7	17.3
South America:					
Argentina	1.5	2.1	2.2	1.6	2.6
Brazil	4.7	5.5	3.8	3.5	5.8
Colombia	2.8	2.9	3.2	2.7	3.3
Venezuela	1.7	1.3	2.2	2.2	2.3
Other	1.9	1.4	1.6	2.0	2.0
Total	12.5	13.3	13.0	12.0	15.9
Asia:					
Japan	8.2	8.3	8.4	9.3	10.4
South Korea	1.9	1.4	1.3	1.0	1.5
Malaysia	1.2	1.5	1.5	1.8	1.4
Singapore	1.6	1.5	1.8	2.2	1.5
Taiwan	1.2	1.6	1.2	1.5	1.6
Other	8.6	8.5	8.3	7.1	6.5
Total	22.6	22.8	22.5	22.9	22.9
West Europe:					
Belgium and Luxembourg	7.6	6.3	7.0	8.0	10.6
France	2.8	2.6	2.1	2.9	3.3
West Germany	5.9	3.5	4.2	5.6	2.8
Italy	1.2	1.4	1.1	1.5	2.1
Netherlands	3.1	4.5	6.2	4.9	6.9
Switzerland	9.3	8.0	7.0	5.8	4.2
United Kingdom	2.6	3.2	3.4	4.1	2.6
Other	2.6	2.9	2.4	3.1	2.6
Total	35.1	32.4	33.4	36.0	35.3
East Europe:					
Total	0.4	0.3	0.2	0.6	0.9
Oceania:					
Australia	2.6	4.0	3.9	3.2	3.1
Other	1.0	1.5	1.2	0.8	0.7
Total	3.6	5.5	5.1	4.0	3.8
Total	100	100	100	100	100

1/ Totals may not add due to rounding. Based on total exports from Table 19.

Table 21--U.S. pesticide imports, region and country share 1/

Region/Country	1982	1983	1984	1985	1986
			Percent		
Africa:					
Total	NR	NR	NR	0.1	0.3
North and Central America:					
Canada	2.2	3.4	2.4	0.7	0.7
Mexico	0.3	0.9	0.4	0.7	0.8
Other	0.1	NR	*	0.7	0.2
Total	2.6	4.3	2.9	2.1	1.7
South America:					
Brazil	2.1	4.3	5.1	5.8	13.0
Other	1.1	1.3	0.8	1.1	1.3
Total	3.2	5.6	5.9	6.9	14.2
Asia:					
Israel	2.9	4.0	6.3	4.4	5.6
Japan	9.9	8.3	4.2	3.3	4.0
Other	0.6	0.6	0.4	1.2	1.0
Total	13.4	12.9	10.9	8.9	10.6
West Europe:					
Belgium and Luxembourg	5.8	3.1	5.2	5.7	5.6
Denmark	3.0	3.8	3.0	2.9	5.9
France	2.9	3.1	4.2	4.5	5.5
West Germany	21.2	18.7	21.9	24.3	16.4
Italy	6.5	8.1	6.7	5.7	10.7
Netherlands	2.9	4.9	4.5	6.3	6.3
Switzerland	29.7	25.5	23.2	23.0	8.7
United Kingdom	6.7	8.4	10.7	8.6	12.5
Other	1.5	1.1	0.9	0.8	1.5
Total	80.2	76.7	80.2	81.9	73.1
East Europe:					
Total	0.7	0.6	*	NR	0.1
Oceania:					
Total	NR	NR	NR	*	NR
Total	100	100	100	100	100

NR = None reported. * = Less than .05 percent.
1/ Totals may not add due to rounding. Based on imports of technical material from Table 19.

($43 million) in 1986, making Brazil the second largest U.S. supplier. Transhipping products to the United States through a second country that has favorable tariff treatment with the United States, (such as the General System of Preferences or GSP) has distorted some traditional trade patterns. The United States recognizes Brazil, along with Israel, as GSP countries.

In the United States, specialized and highly complex production facilities, as well as extensive research and development programs partially account for the Nation's growing export trade. The recent weakening of the U.S. dollar may further spur U.S. exports and discourage imports. Planted acreage increases in other parts of the world, such as Africa and Latin America, provide growing markets for U.S. pesticides. However, the large and burdensome external debt held by many of these countries discourages imports.

Multinational firms involved in the international pesticide market may find that exporting a material from a specialized plant to a foreign market is more efficacious than building a small plant to serve a limited market. However, many countries have established their own pesticide production capability reducing the need for imports. Government-owned facilities can affect international pesticide trade due to pricing and trade policies that do not reflect true production costs. A variety of other factors affect publically or privately financed plant construction or expansion including: the political stability of the country; the size of market within the country; the host country's provision to protect a patented product or patented manufacturing process; the ability to competitively export products to other major markets around the world, including the United States and Europe; the cost of labor, energy, petroleum or other raw materials; government willingness to help finance the facility, which is often related to a country's goal of ensuring a steady supply of reasonably priced pesticides for food self-sufficiency; and a country's strategy to generate foreign currency through exports or save foreign currency by reducing imports.

FERTILIZER

Use

Plant nutrient use probably fell for the third consecutive year to about 18.5 million tons in the 1986/87 fertilizer year (July 1 – June 30). This 6-percent decline was primarily due to reduced crop plantings, especially corn. Corn acreage, which generally accounts for over 40 percent of total plant nutrient use, fell 14 percent from a year earlier.

Crop prices at planting were below 1986 levels for most major crops, but fertilizer prices were also down by more than 6 percent. Consequently, fertilizer application rates in 1987 on cotton, soybeans, and wheat likely were close to year-earlier levels. The rate of phosphate applied to corn probably remained relatively stable, while nitrogen and potash application rates may have increased. Average per acre use of both nitrogen and potash on corn fell about 8 percent from 1985 to 1986. These rates may have increased in 1987, however, as marginal, less intensively fertilized corn acreage was taken out of production under Government programs.

Supplies

Domestic fertilizer supplies in 1986/87 were down from a year ago, but adequate to meet this year's crop needs. During July-May, nitrogen supplies were down 8 percent as exports increased and production declined (table 22). Phosphate supplies declined 12 percent because of a 36-percent increase in exports. A decline in potash imports offset larger production, lowering potash supplies by 10 percent.

Trade

Increased world fertilizer demand and stable or declining prices in 1986/87 spurred U.S. fertilizer exports. Phosphate exports from July 1986 through May 1987 increased 36 percent, primarily because of a 1.4-million-ton increase in diammonium phosphate (DAP) and a 354,000-ton-increase in wet-process phosphoric acid exports. China returned to the market, after dramatically reducing 1985/86 purchases because of large imports the previous year and an attempt to conserve foreign exchange. Increased purchases by

Table 22--U.S. fertilizer supplies 1/

Item	1985/86	1986/87	Change
	Million short tons		Percent
July 1 inventory:			
Nitrogen (N)	1.42	1.83	+29
Phosphate (P_2O_5) 2/	.77	.62	-20
Potash (K_2O)	.30	.29	-3
Production:			
Nitrogen	11.71	10.97	-6
Phosphate 2/	8.72	9.08	+4
Potash	1.11	1.24	+12
Imports:			
Nitrogen	3.88	3.63	-6
Phosphate 2/	.10	.11	+10
Potash	4.66	4.07	-13
Exports:			
Nitrogen	1.86	2.48	+33
Phosphate 2/	4/ 2.87	4/ 3.89	+36
Potash	.46	.57	+24
Domestic supply: 3/			
Nitrogen	15.15	13.95	-8
Phosphate 2/	4/ 6.72	4/ 5.92	-12
Potash	5.61	5.03	-10

1/ Data for July through May for the fertilizer year starting July 1. 2/ Does not include phosphate rock. 3/ Includes requirements for industrial uses. 4/ Does not include exports of superphosphoric acid because of a data reporting change by the U.S. Department of Commerce in July 1985. Thus, phosphate exports are understated and domestic supply is overstated.

China accounted for over half the gain in U.S. DAP exports in 1986/87.

Nitrogen exports also increased 33 percent as a result of the increase in DAP exports and a 319,000-ton rise in exports of anhydrous ammonia. Potash exports were up 24 percent; exports of potassium chloride and potassium sulfate increased by 20 and 76 percent, respectively.

Lower domestic nitrogen prices and use projections have discouraged nitrogen imports. Nitrogen imports during July-May fell 6 percent to 3.6 million tons as imports of anhydrous ammonia fell 14 percent. Nitrogen imports were also affected by an anti-dumping case against urea imports from Eastern Europe filed by domestic nitrogen producers during July 1986. In December, the U.S. Department of Commerce required importers of urea from East Germany, Romania, and the Soviet Union to post bonds, thus raising import prices. Consequently, urea imports from these countries fell 56 percent (680,000 tons) from a year earlier, with most of the decline occurring since November.

Despite the decline in Eastern European urea imports, total U.S. urea imports through May 1987 actually increased 3 percent over the comparable July-May 1986 period. Urea imports from Canada and Italy increased 227,000 and 155,000 tons, respectively, while imports from the Netherlands, Trinidad-Tobago, and Venezuela increased by 196,000 tons. Urea imports from new suppliers like Kuwait, Yugoslavia, and the United Arab Emirates accounted for an additional 323,000 tons.

Potash imports were also discouraged by lower use projections. Potash imports declined in July-May as imports of potassium chloride fell 13 percent. Most of this drop resulted from a 13-percent decrease in imports of potassium chloride from Canada, which generally supplies over 90 percent of total U.S. potash imports. An anti-dumping case against Canadian potash, while having little impact on Canada's share of U.S. potassium chloride imports through May 1987, could slow future potash imports from Canada. While a decision by the Department of Commerce is still pending, the International Trade Commission in March ruled that U.S. potash producers have been materially injured by imports of Canadian potash.

Production

Domestic nitrogen production declined 6 percent to 11 million tons during July-May, primarily because of reduced domestic use. Production of phosphate and potash increased, however, as a more favorable trade situation offset the decline in domestic use. Phosphate production increased 4 percent to 9.1 million tons while potash production was up 12 percent to 1.2 million tons.

Prices

Although fertilizer supplies were below 1985/86 levels, average farm fertilizer prices in April 1987 fell by more than 6 percent from a year earlier because of reduced domestic use. Nitrogen fertilizer prices were down the most as anhydrous ammonia prices fell by 17

percent (table 23). Phosphate prices were closer to year-earlier levels as prices of DAP and triple superphosphate increased and decreased by 2 percent, respectively. Potash prices increased 4 percent as decreased imports lowered supplies.

Table 23--Average U.S. farm prices for selected fertilizer materials 1/

Year	Anhydrous ammonia (82%)	Triple super-phosphate (44-46%)	Diammonium phosphate (18-46-0%)	Potash (60%)	Mixed (6-24-24%)
	Dollars per short ton				
1984	280	231	271	147	217
1985	252	203	240	128	192
1986	225	190	224	111	179
1987	187	194	220	115	176

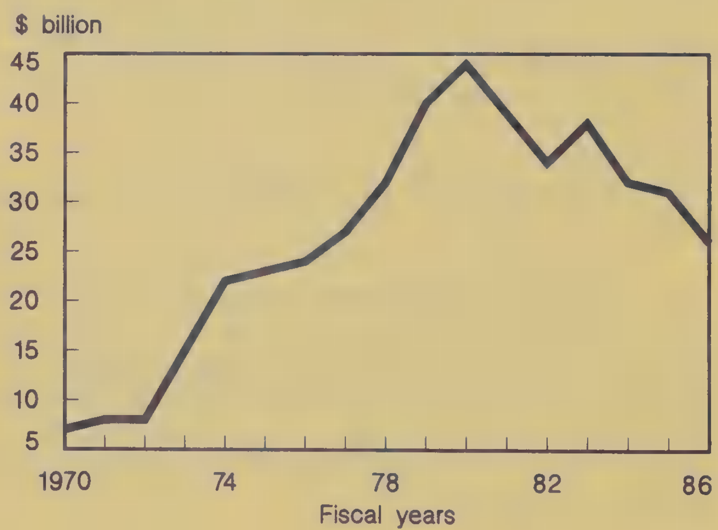
1/ Based on surveys of farm supply dealers conducted by the National Agricultural Statistics Service, USDA. Prices are for May in 1984 and 1985 and April in 1986 and 1987.

Appendix A
The Domestic Farm Machinery Inventory Situation
by
Carlos Sisco

One of the most serious problems in the North American farm machinery industry since 1979 has been its inability to reduce production as rapidly as unit sales have declined. As a result, new farm machinery inventories have become excessive relative to demand over the past 6 years, especially for over-99 horsepower (hp) wheel tractors and self-propelled combines. Consequently, manufacturers have been offering a wide range of price discounts and sales incentive programs to lower inventories and to enable them to continue to operate plants at minimal levels.

The current inventory situation evolved from strong growth that characterized U.S. agriculture during the 1970's. In the 1970's, economic growth in developing and centrally planned economies, coupled with a declining value of the U.S. dollar abroad, increased world demand for U.S. agricultural exports 357 percent from $7 to $32 billion. Over the same period, the annual index of crop prices received by farmers jumped 123 percent. The gains in both the volume of U.S. agricultural exports and crop prices encouraged farmers to expand their operations. Planted acres rose 18 percent during the 1970's from 293 to 347 million. Concurrently, low real interest rates encouraged farmers to seek financing for additional capital investments.

U.S. Agricultural Exports



Under the stimuli of rising farm commodity prices, expanding crop acreage, declining real interest rates, and a doubling of farm real estate values, demand for large-sized farm equipment accelerated. Manufacturers responded by adjusting their marketing strategies and retooling their plants toward the production of large-capacity farm machinery.

At the same time, manufacturers established or expanded their foreign operations by transferring the entire U.S.

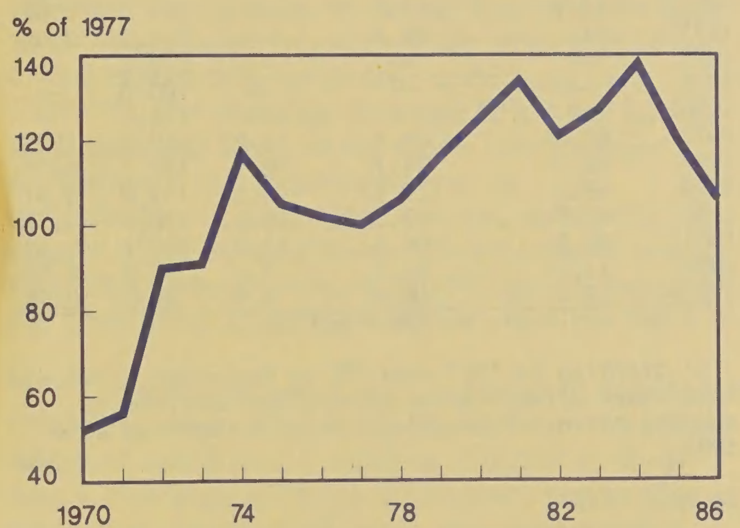
40–99 hp (mid-size) wheel tractor production capacity to Western Europe. Also, domestic manufacturers began to contract with Japanese firms to produce the under-40 hp (compact) tractor. These decisions allowed domestic manufacturers to take advantage of economies of scale in large-equipment production.

The 1970's represented one of the most significant junctures for the domestic farm machinery industry. Possibly no other farm input industry benefited as much during this growth period in U.S. agriculture than the farm machinery industry. However, by being so closely aligned with the agricultural sector, the farm machinery industry is subject to its inherent volatility.

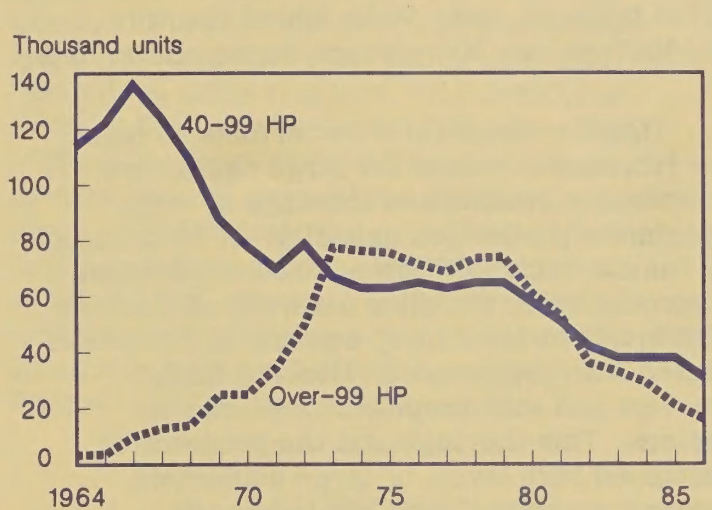
The Inventory Problem

While 40–99 hp unit sales dominated the two-wheel drive tractor market in the mid-1960's, by the early 1970's, farmers were purchasing greater quantities of large tractors. Between 1964 and 1969, annual over-99 hp wheel tractors sales averaged 11,500 units. However, in 1973, as net farm income peaked, over-99 hp two-wheel drive tractors sales reached a record high of 71,400 units, about 6 times the 1964–69 annual average. Accordingly, the average per unit size for all new over-40 hp tractors sold rose approximately 44 percent from 68 hp in 1964 to 95 hp in 1973. Also, large-capacity self-propelled combine unit sales rose 46 percent from 13,400 in 1972 to 18,900 in 1973

Annual Crop Prices Received by U.S. Farmers

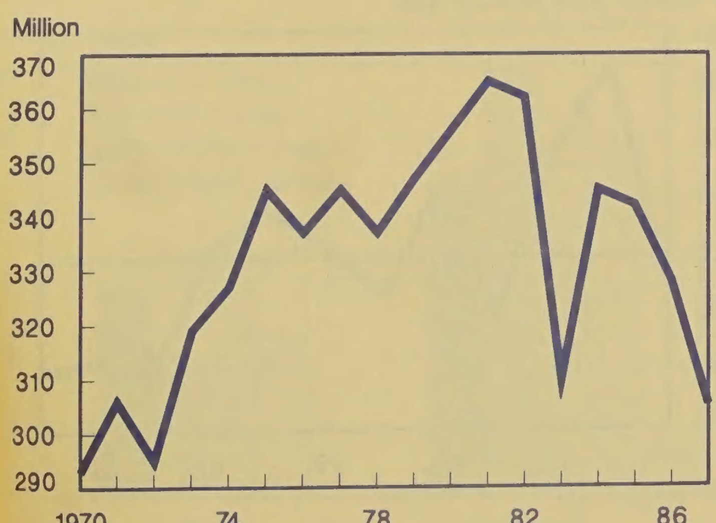


U.S. Tractor Sales

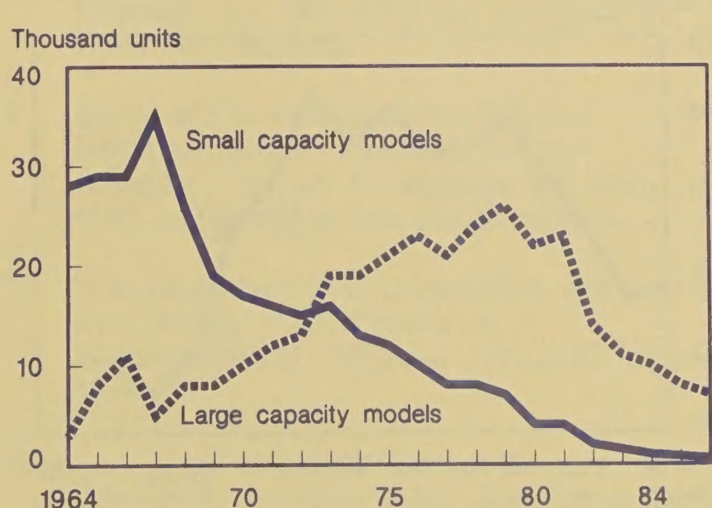


Farm wheel-type tractors. Source: (1).

U.S. Planted Acres



U.S. Sales of Self-Propelled Combines



Farm wheel-type tractors. Source: (1).

which represented over 50 percent of the industry's total self-propelled combine sales.

In response to these shifts, domestic manufacturers increased output and shifted production to higher capacity equipment. For example, the Federal Reserve Board's farm equipment production index is a measure of production activity within the farm equipment sector. The index indicates a near 50- percent increase in farm machinery production during the 1970's. In 1970, the industry's production ratio for under-99 wheel tractors to over-99 hp models stood at 6.5 to 1. By 1973, the ratio narrowed to 2 to 1. However, the narrowing of the ratio is understated because no four-wheel drive wheel tractor production data were publicly reported in 1973. In 1979, the production ratio switched to 1.35 to 1 in favor of large tractor production (appendix table 1). Between 1970 and 1979, over-99 hp two-wheel drive wheel tractor production rose 230 percent. Taking into account four-wheel drive tractors, over-99 hp wheel tractor production rose 300 percent during the 1970's.

Despite manufacturers' efforts to meet the increased demand for large equipment, there was a pronounced shortage of large equipment production capacity. A 1976 report by the Executive Office of the President on Wage and Price Stability determined that the high levels of machinery demand in the 1970's caused manufacturers to allocate large tractors and self-propelled combines to dealers. This shortage and the prospect of continued high levels of large equipment demand, combined with the industry's traditional orientation towards maintaining inventory levels sufficient to balance out seasonal fluctuations in equipment demand, led to the development of an operating strategy formulated to eliminate inventory shortages.

Specifically, this strategy entailed manufacturers operating plants at high rates of capacity and increasing new capital investment. Available data indicate that the farm machinery industry operated at near full capacity in the 1970's. New capital investment adjusted by the GNP deflator

Appendix Table 1--Wheel tractor production

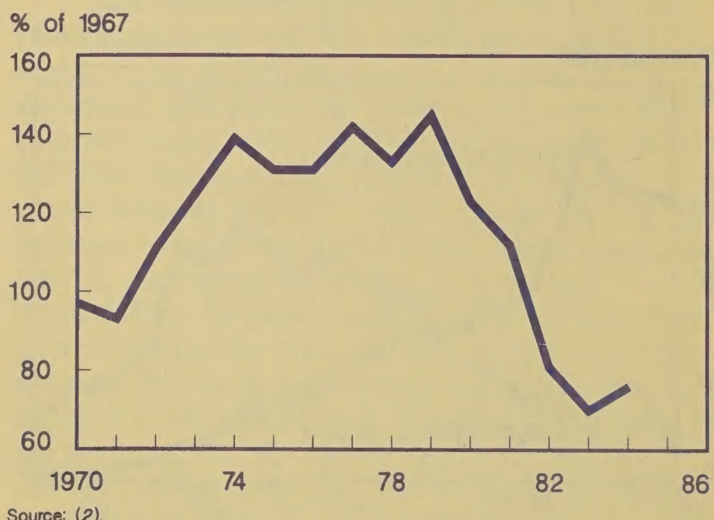
	Under-99 hp two-wheel drive	Over-99 hp two-wheel drive	4-wheel drive	Total	Ratio 1/
	1,000 units				
1970	148.8	22.8	--	171.6	6.35
1971	131.0	36.5	--	167.5	3.59
1972	142.7	54.5	--	197.2	2.62
1973	142.1	69.4	--	211.5	2.05
1974	--	--	--	175.8	--
1975	--	--	--	186.8	--
1976	--	--	--	176.0	--
1977	87.0	69.4	11.8	168.2	1.25
1978	55.3	71.7	10.3	137.3	0.77
1979	68.2	75.3	16.3	159.8	0.91
1980	43.7	59.5	15.6	118.8	0.73
1981	41.3	66.6	12.2	120.1	0.62
1982	21.5	38.3	7.1	66.9	0.56
1983	14.3	28.8	4.9	48.0	0.50

-- = Not available or not reported.

1/ Starting in 1977 over-99 hp two wheel drive and four-wheel drive tractor production combined to compute ratio. Production data not reported after 1983.

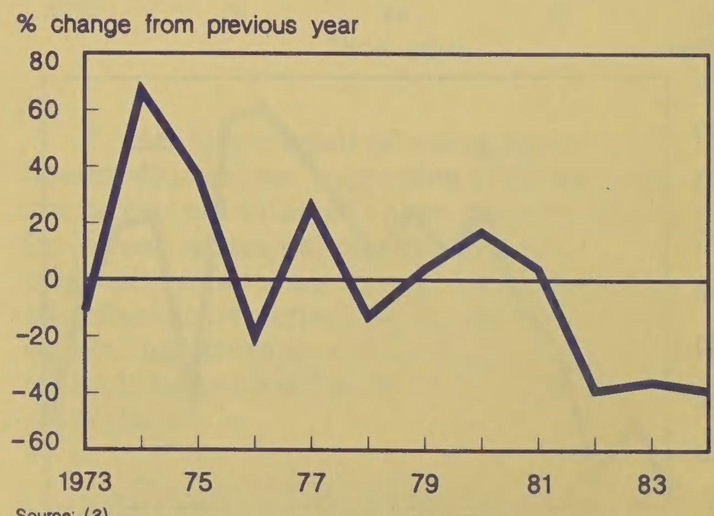
Source: (4).

U.S. Farm Machinery Production



Source: (*2*).

Real New Capital Investment



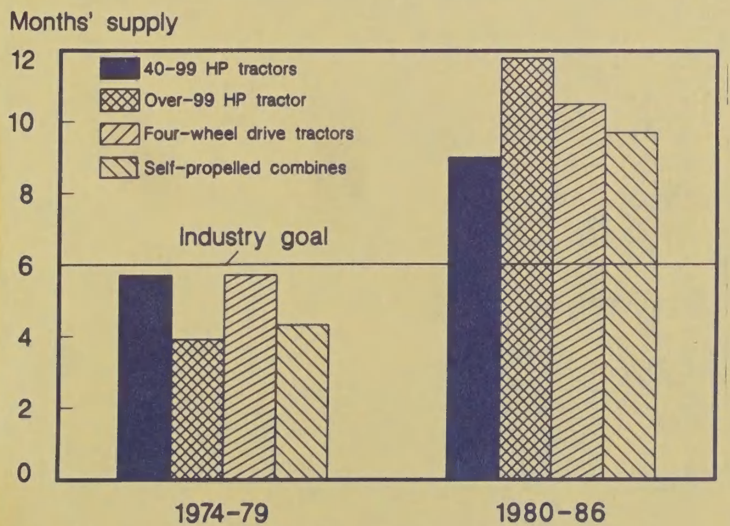
Source: (*3*).

(1972) peaked in 1974, 1977, and 1980; each year preceded a strong period of farm machinery demand. Nevertheless, one can not ascertain the extent to which the growth in new capital investment or high plant operating rates can be solely attributed to the deficiency in large equipment capacity. Inventory-to-purchase ratios (IPR's) can be used to provide a more accurate measure of either an industry's need or desire to increase or decrease the production of a particular item or to add or eliminate production capacity. An IPR is a widely used measure of the inventory of an item relative to its respective unit sales during the previous 12 months.

Most industry experts agree that an IPR generally equivalent to a 6-month supply of farm machinery is the industry goal. Using the 6-month IPR as a base, monthly IPR's for 1974-79 and 1980-86 were computed for 4 machine categories, 40-99 hp and over-99 hp two-wheel drive tractors, four-wheel drive tractors and self-propelled combines. For 1974-79, the monthly average IPR's for both mid-size and four-wheel drive tractors were in line with the industry target as manufacturers maintained a near 6-month supply of these machines. These results imply that there was adequate production capacity for both tractor categories.

Conversely, the 1974-79 monthly average IPR's for over-99 hp two-wheel drive tractors and self-propelled combines imply that there was a shortage of large equipment production capacity. Supplies of large two-wheel drive and self-propelled combines supplies averaged a respective 3.9 and 4.3 months. The low 1974-79 IPR's for these categories provided manufacturers with a clear signal to augment inventories. The build-up was accomplished by sustaining both high operating rates and new capital investment growth from the mid-1970's to the early 1980's. The underlying impetus for this operating strategy was the expectation that large farm equipment unit sales would remain strong throughout the mid-1980's, making expansion profitable.

Average Inventories of Tractors and Combines



The robust growth in the farm machinery demand didn't continue. Because manufacturers did not reduce production enough to match the deterioration in demand, inventories of large equipment, which scarcely averaged a 4-month supply in the 1974-79 period, averaged nearly a 12-month supply during the 1980's. The 1980-86 monthly average IPR's for the four categories were above the target; 9 months for mid-size two-wheel drive tractors, 11.8 months or over-99 hp two wheel drive tractors, 10.8 months for four-wheel drive tractors, and 10 months for self-propelled combines. However, since 1983, several well-documented company mergers and numerous plant closings have reduced total domestic production capacity as well as absolute inventories. But because the industry's hasn't met its inventory goal, further adjustments appear certain.

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